An-Najah National University
Faculty of Graduate Studies

Developing a Methodology for Technology Identification and Selection in Telecommunication Industry
(PALTEL as a case study)

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Dedication

Thanks to all those who supported me to achieve my work successfully.

I dedicate this humble work in particular to my family especially to my mother and father and to my supervisor Dr. Husam Arman who offered his continuous advice and support to me, and every person who encourage me in completing this thesis.

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Finally, I take this opportunity to express the profound gratitude from my deep heart to my parents, and family, for their continuous support both spiritually and materially.

الإقرار

أنا الموقعة أدناه مقدمة الرسالة التي تحمل عنوان:

Developing a Methodology for Technology Identification and Selection in Telecommunication Industry
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وضع منهجية لتحديد وتقييم واختيار التكنولوجيا المستخدمة في الشركات الفلسطينية/ موضوع الدراسة شركة الاتصالات الفلسطينية بالتل

اقر بان ما اشتملت عليه هذه الرسالة إنما هي نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وأن هذه الرسالة ككل، أو أي جزء منها لم يقدم من قبل لنيل أي درجة علمية أو بحث علمي أو بحثي لدى أي مؤسسة علمية أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: …………………………………… اسم الطالب:

Signature: …………………………………… التوقيع:

Date: …………………………………… التاريخ:

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ABBREVIATIONS

AHP	Analytic Hierarchy Process
AMA	American Marketing Association
EIRMA	European Industrial Research Management Association
EITIM	The European Institute of Technology and Innovation Management
FTA	Future Oriented Technology Analysis
MCDM	Multi Criteria Decision Making Tool
NRC	National Research Council
RFP	Request For Proposal
R&D	Research and Development
SDD	Service Discription Documentation
TEA	Techno-Economic Analysis
TF	Technology Forecasting
TFA	Technology Futures Analysis
TFAMWG	The Technology Futures Analysis Methods Working Group
TI	Technology Intelligence
TM	Technology Management
TRM	Technology Roadmapping

**Developing a Methodology for
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Abstract

Telecommunications industry is one of the most influential and significant global industries. As well as being fundamentally important to the health of the modern economy, it is going through a period of unprecedented change, facing a range of strategic challenges from globalization and cross-border alliances, to changing technologies and consumer demands.

Telecommunications industry is seeing rapid and ongoing change. With emerging technologies, and increased consumer demand, companies are presented with a wide range of opportunities and challenges in order to sustain competitive advantage.

Telecom managers are aware of the strategic importance of technology in delivering value and competitive advantage to their companies and the industrial networks in which they operate. These issues are becoming more critical as the cost, complexity and rate of technology change increases, and competition and sources of technology globalize. The management of technology for business benefit requires effective processes and systems to be put in place to ensure that existing and

potential technological resources within the organization are aligned with its needs, now and in the future. In addition, the impact of changes in technology and markets need to be assessed, in terms of potential threats and opportunities, including disruptive technologies and markets.

Identifying the right technology used by telecommunication companies and selecting the appropriate and up-to date one is critical and should be to taken into account with high priority. This research investigates the application of technology identification and selection to support technology investment strategies. By the research question and the gap identified in the related literature review, an improved technology identification and selection framework has been developed during the research period.

The main purpose of this research is to develop a generic technology identification and selection framework for Palestinian telecom companies that can be used to support them through integrating technology management activities.

Chapter One

Introduction

1.1 General Overview:

During the past century, the operating environment has become more complex, and technology's role has become significant in increasing productivity, innovations and business model development. Companies are constantly struggling in adapting to technology changes, and optimizing investments for new opportunities in the marketplace. Therefore, the underlying need for companies is the capability of creating and executing business and technology strategies for value creation and sustained competitiveness.

Profound understanding and capabilities on technology management are crucial for the companies due to the critical role of technology in creation and execution of company strategy (Burgelman,2001, Chiaromonte,2003 and Dodgson,2008). The effective integration of technological considerations into business strategy is an important aspect of business planning. A key premise is that a technology strategy should not be developed independently from the business strategy, but rather that technological resources should be considered as an integral part of business planning (Matthews .1992 , Bitondo & Frohman 1981).

Technological development is becoming very important to all firms competing in global highly competitive environment. The increasing of customer needs, demand, and expectations and with the accelerated rates of technological change and development, business owners are becoming more conscious of the strategic importance of technology in delivering value to their companies and networks in which they operate. However, adopting new technologies should be aligned with organization's vision and strategic goals, and it should support the company's sustainable development and enhance its performance.

The Palestinian telecommunication sector plays an essential role in the economic development process. Even so this sector faces many challenges and obstacles that stand in the way of its growth and development to keep up with technological developments in the world. These are mainly attributed to the instability of the political issues and the Israeli occupation which affect the sectors as follows:

- Preventing the telecom sector from running the third generation,

- Not giving the telecom sector enough and sufficient frequencies necessary for the operation of modern services,

- Restrictions on importing devices and communications equipments

Identifying the right technology used by telecommunication companies and selecting the appropriate and up-to date one is consider very

critical issues that should be to taken into account with high priority. This research investigates the application of technology identification and technology selection to support technology investment strategies.

Based on literature findings, technology management concept and by understanding the current enterprise practices, an improved technology identification and selection framework has been developed during the research period. The main purpose of this research is to develop a generic technology identification and selection framework for Palestinian telecom companies that can be used to support them through integrating technology management activities.

This chapter aims to introduce an overview of the research title, research approach, and background. Furthermore, this chapter addresses the problem statement, research questions, research objectives, and the structure of this thesis.

1.2 Research Questions:

The research questions have been formulated based on the literature review in chapter two and a series of interviews with the concerned people to identify technological challenges of the company and observe the gap between the current application of technology management in research environment, and global technology management activities illustrated in literature review chapter. The research questions were formulated as follows:

1. How can telecom companies identify the technology they need?

2. How can telecom companies select the appropriate technology?

3. what are the methods, criteria, and tools that should be used by the company in the selection process?

4. What is the suitable integrated technology identification and selection framework that can be used to leverage company's performance?

5. How can companies keep pace with technological developments which will have significant impact on the companies' development and success?

1.3 Research aims and objectives:

The main aim of this research study is to develop a generic technology identification and selection model that can be useful to guide the technology management strategy for telecommunication industry and help companies make the right decision regarding the adoption of modern technology that enable them to keep abreast of modern developments in the field of communications . Five further objectives are listed below;

1. To investigate the role of technology management activities in providing competitive advantage for companies.

2. Identify the relevant concept in technology identification and selection that can be applied in telecommunication sector.

3. Evaluate the current practices with regard technology identification and selection activities at PALTEL and identify the basis and principles they adopt in selecting new technologies.

4. Developing a methodology that helps the decision makers in the company to take the right decision, using the right criteria, right tools in choosing and selecting right technology.

5. Validate the resulted model in a real scenario (PALTEL case study).

1.4 Research Design and Methodology:

The methodology followed in this research is summarized as follows:

1. Conducting a literature review:

This is largely designed to review existing literatures and publications on the concept of technology identification and selection, and to which recent significant studies and reports related to this subject.

2. A series of structured meetings and interviews:

Conducted with involved people and decision makers of the selected company in order to:

a. Determine to what extent the company pursuing technological development in the world

b. Evaluating the companies understanding of the concept of technology identification and selection

c. Assessing the level of interest in performing and developing technology selection

d. Clarifying the obstacles faces the company when acquiring new technologies

e. Determine if the company follows a particular methodology in selection the new technology when it intended to adopt it

f. Identifying the criteria the company use in selecting the appropriate technology that the company need to posses

3. Main contribution:

In this part the researcher will explore and identify the results of the interviews and the observation where notes were taken during the assessment on site. The analysis will be used to achieve the following:

✓ Determining the importance of technology identification and selection in the management process

✓ Determining the gap between practice and theory.

✓ Designing conceptual framework module

✓ Implementing the framework in a real scenario (PALTEL case study)

1.5 Research boundaries and limits:

The field of technology management has emerged to address the approaches in which companies should enhance technology in their business functions. Widely used definition describes Technology Management as a process, which includes planning, directing, controlling and coordination of the development and implementation of technological capabilities to shape and accomplish the strategic and operational objectives of an organization (Wang, 1993).

Within the technology management framework defined by (Gregory 1995), this research study attempts to address the first and second processes in Gregory's framework which consists of management concepts that aim in identifying technologies which are (or may be) of importance to the business. The second process of technology management is the selection process of technologies that may have a significant impact on the company's business strategy

Figure 1-1 shows the process of "Identification" and "selection "within the five processes of technology management. The "Identification" phase is followed by a "Selection" phase. (Gregory,1995) considers each as a separate process while for example (Dussauge,1992) regard both processes as one process called "technology selection". The issue that is highlighted by these definitions is the importance of having a process to

generate and evaluate alternative and additional/new technologies that are relevant to the firm's business.
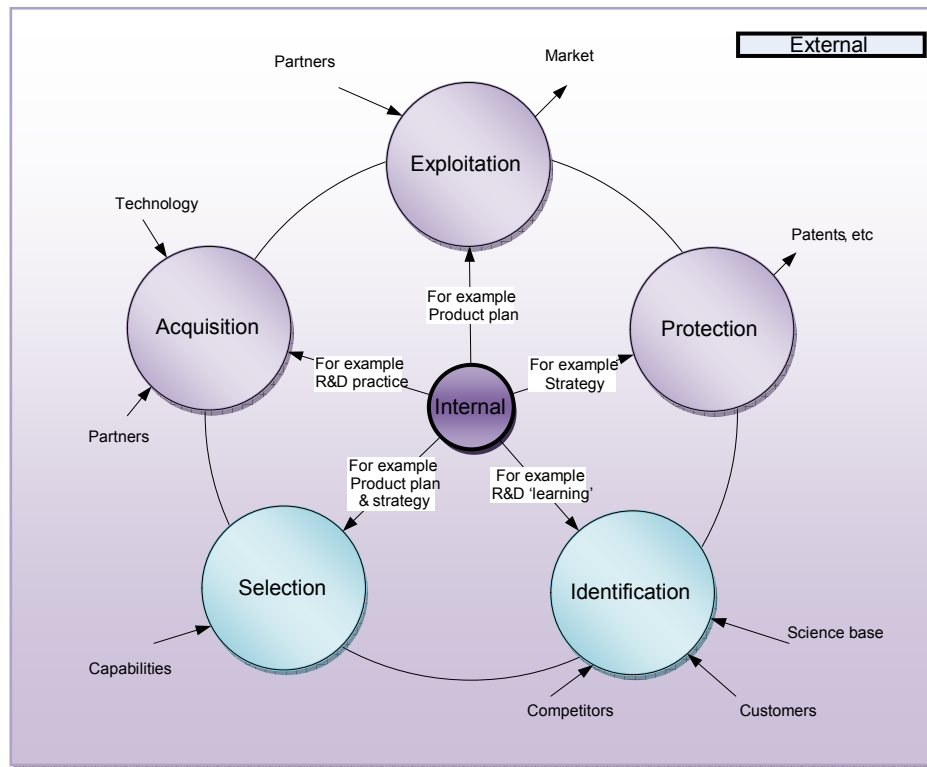
Figure (1-1): 'Identification' and "selection" within five-processes technology management framework Gregory (1995)

1.6 Expected Result of the study:

The basic key element that would be expected from the study can be summarized as follows:

✓ Contribute to the understanding of the concept "technology identification and selection"

✓ Developing of technology selection methodology that will be useful to the company in taking their decision regarding the new technology they will adopt.

1.7 Thesis outline:

The thesis consists of six chapters as shown in the Table (1):

The first chapter will be introduction to the research study which outlines and clarifies the character of the study. Following the introductory chapter, chapter 2 reviews relevant literature and background in the fields of related management concepts and technology identification and selection field. Chapter 3 presents in some detail the research methodology used for this particular research.

Chapter 4 introduces the technology identification, and selection methodology applies in PALTEL company. Chapter 5 will display the framework and its implementation process. Finally, Chapter 6 will conclude the study through an articulation of the research findings, and conclusions.

Table (1): Thesis structure

Chapter No.	Chapter title
Chapter One	Introduction
Chapter Two	Literature Review
Chapter Three	Research Design and Methodology
Chapter Four	Technology Identification and Selection in PALTEL telecom company
Chapter Five	Technology Identification and Selection Model
Chapter Six	Conclusions & Recommendations

Chapter Two

Literature Review

2. Literature review:

2.1 Introduction:

This chapter discusses technology management practices and review wide variety of concepts and terminologies that present and explains the term technology, disruptive technology, technology management, strategic technology management, technology identification, forecasting, scanning and monitoring, and selection. This chapter addresses three major topics. The first part of the literature discusses the technology management issues and displays the role of technology management and its framework; this will be presented in section **2.2.** The second part of the literature review discusses the scientific studies related to technology identification and its related activities such as technology forecasting, technology scanning and monitoring, technology intelligence and technology road mapping and these are presented in section **2.3.** The third part addresses the selection process of the technology and identifying the approaches, tools, criteria and framework used in the selection process and its importance in decision making process and these are addressed in section **2.4**

2.2 Technology Management:

2.2.1 Technology concept:

The definition of the term technology is difficult to pin down. According to (Niiniluoto, 1980) the definition of each term is dependent on its intention and relation to the concept. Each technology term has its own understanding and interpretation of the technology concept. "Technology" can have many other meanings and can refer to the various systems and processes when humans satisfy their needs by transforming their available resources.

(Ferré, 1988) has defined technology as "practical implementations of intelligence". Technology can also mean skills to apply proper techniques (Hakkarainen, 2006) or practical application of knowledge (Webster 2010). 'Technology' is also defined by (Steele, 1989) as 'knowledge of how to do things', or 'capabilities that an enterprise needs in order to provide its customers with the goods and services it proposes to offer, both now and in the future'.

(Burgelman, 2001) defines technology as "technology refers to theoretical and practical knowledge, skills and artifacts that can be used to develop products and services as well their production and delivery systems. (Floyd 1997;Steele 1989;Whipp 1991) describe the technology as applied knowledge focusing on the "know-how" of the organization. In many different bodies, one can recognize technology such as equipment,

human resources, raw materials, as well as cognitive and physical processes.

Currently, due to the huge potential that technology has to reduce the cost of production and operating as well improving the quality of products and services, technology is becoming more prevalent in a business context.

2.2.2 Technology management process:

Due to the competitive advantage that can be derived from the successful use of technology, corporations have become more conscious of the value of technology when it is applied in their businesses.

Nowadays, in the rapid changing environment with increasing cost, complexity, competition and rate of technological changes, the needs for technology management has become an urgent issue for every company and organization (Steele, 1989).

Developments and advances in technology bring with them opportunities and threats to the development of new products, the level of diversification present within industry and the services and processes implicit in these. Thankfully, effective technology management can ensure that such opportunities can be turned into value. Innovation and development within business is acknowledged as being primarily driven on by technology. Given the constantly changing nature of technology, and the consequent difficulty in managing it, business must employ more

comprehensive approaches whilst managing such technologies. The effective management of technology as a source of competitive advantage is of vital importance for many organizations (Dussauge, 1994). Effective technology management encompasses all methods of integrating corporate decision making into technological issues, and has a relevance to many corporate processes such as operations management, innovation, product development and strategy development. The comprehension, communication and integration of technology strategy with the different corporate departments such as financial, marketing, human resources and operations is obviously a crucial goal.

In order to aid businesses to successfully control and manage technologies in their work, the new field of technology management has emerged so that businesses can successfully overcome the different challenges and obstacles they encounter whilst using technology.

A widely used definition describes TM as "a process, which includes planning, directing, control and coordination of the development and implementation of technological capabilities to shape and accomplish the strategic and operational objectives of an organization" (NRC/National Research Council, 1987).

The European Institute of Technology and Innovation Management (EITIM, 2007) defines technology management as follows: " Technology management addresses the effective identification, selection, acquisition,

development, exploitation and protection of technologies (product, process and infrastructural) needed to achieve, maintain and grow a market position and business performance in accordance with the company's objectives"

The above definition highlights two important technology management issues:

1. How important it is that links are maintained between the goals of businesses and their technological resources. Specific frameworks have been developed by some researchers to remedy the complications inherent in the formation of such links, and thereby improve technology management related issues understanding in the company.

2. 5 Processes proposed by Gregory see Figure 1-1, are included in the effective technological management of particular management processes and they are: identification, selection, acquisition, exploitation and protection of technology.

2.2.3 Role of Technology and Technology Management:

While technology is now accepted as a source of competitive advantage (Maidique, Patch 1988). Mitchell (1990) states that firms have sometimes failed to sufficiently warn business management of dominant trends or opportunities arising as a result of technology, despite success during the 1970's and 1980's of strategic planning.

Probert . (Probert , Phaal,. and Farrukh, 2000) state that technology is multidisciplinary as it combines a wide range of faculties such as science, management and engineering. Also, in a manufacturing business deliberation upon these issues is contingent upon the requirement of skills and knowledge of individuals within various roles and departments.

Skilbeck and Cruickshank (1997) state that inclusive in technology management are activities that pass through intra organizational boundaries and disciplines and can also be present in businesses so as to form and maintain technology based competitive advantage in an ever changing market.

Tarr (1991) argues that, the controlled introduction and use of technology in products, internal organizational functions, is included in the management of technology and is aside from the innovative processes present in R&D.

The primary goal is to successfully integrate technology into general business operations as opposed to isolating technology within special-purpose functions.

According to (Tschirky,1997) the aim of technology management is to eradicate the gap between practice and theory in general management theory. This can be achieved by linking management ideas to technological knowledge. Tschirky views technological management as an integrated part of general management that tries to integrate technology

into management, as a framework of integrated technology management ,
(Tschirky, 1997).

Three levels of management tasks are differentiated by Tschirky. He
places a higher normative level of management over the organisational and
strategic levels. See Figure 2-1

Figure (2-1): Three levels of management (Tschirky, 1997)

- **Normative level:** This level deals with the company's major
  decisions, that vividly demonstrate its associated culture and policy

- **Strategic level:** a comprehensive technology strategy, with a
  dominant principle of effectiveness is translated into the company's
  policy

- **Operative level:** this changes the businesses strategies into practice
  over the short term, with efficiency as the primary principle.

2.2.4 Technology management framework:

A set of management definitions, concepts, activities, stages, and procedures Researchers have developed a range of concepts, stages, procedures, activities and management definitions, all of which are directed towards forming and articulating a certain framework of technology management as the TM methodology.

In order to: explore the methods and techniques of technology management; identify and investigate the meaning of technology management; and to clarify its functions, various Technology Management models, frameworks, definitions, concepts, assumptions, and proposals have been articulated. (Sarkis,J. 1995; Dey., 1996; Chan,S.L and Choi C.F, 1997; Lopes and Flavell, 1998; Haas and Kleingeld, 1999; Garshnek et al., 2000; Pretorius and Wet, 2000; Sharratt and Choong, 2002;).

Gregory (1995) described technology management; see Figure 2-2 as a five step model which includes identification, selection, acquisition, development, exploitation and protection of technologies (product, process and infrastructural), which in adherence to the company's objectives, are needed to uphold company performance and market position
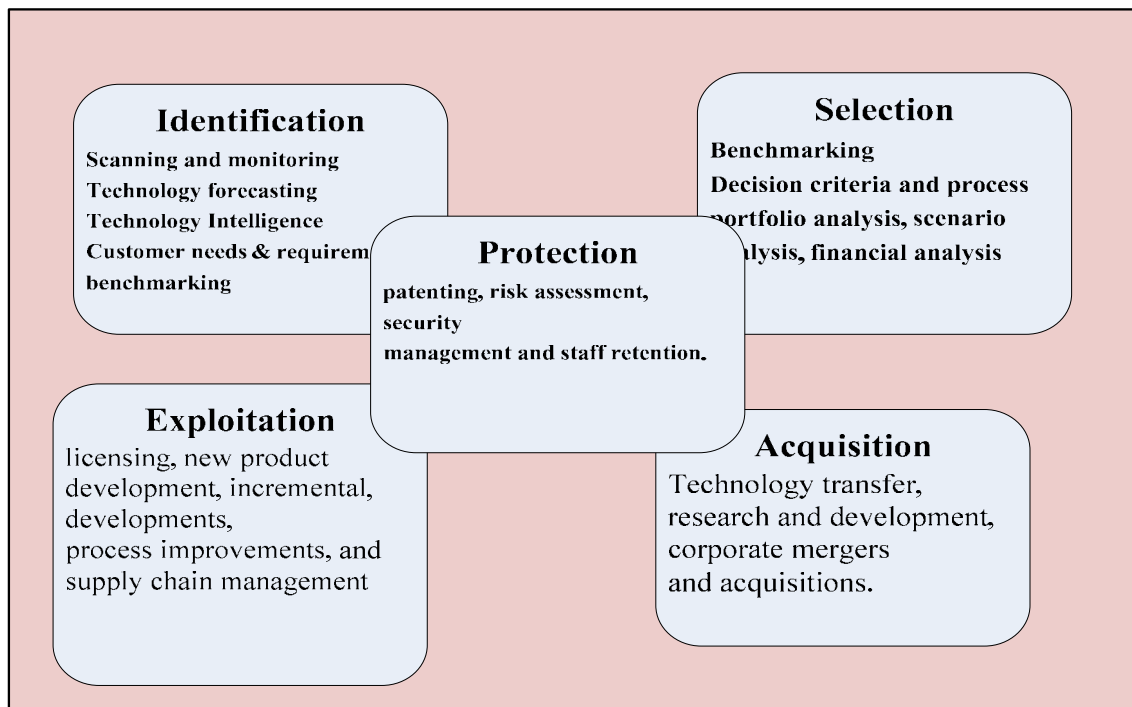
Figure (2-2): A five process model to describe technology management (Gregory; 1995)

1. Identification: The spine of the management process is seen to be the identification of technologies, crucial to the company's strategic operations. Such identification processes include: scanning and monitoring, technology forecasting, customers orientation, technology intelligence, data collection and benchmarking. Such work will show how the business identifies the technologies it uses, how the company forecasts for success of new technology, how scanning and monitoring for the new technologies are performed, how the company identifies the customer needs and requirements, and what are the main factors that affect the identification process.

2. Selection: selection of those technologies that are chosen to support companies and organization. Such processes include: scenario analysis, portfolio analysis, expert judgment, decision criteria and financial analysis. Since technology selection requires one to make accurate decisions with regards to the correct technologies, it is crucial for the organization. This is especially so when decisions are made that require long term investments. Also, the business must concentrate on quantitative, qualitative, intangible and tangible criteria in the selection of its technology. This process is necessary so that the business adopts systematic procedure in its selection process.

Any decisions made on the choice of such technology must be in line with the strategy and policies of the business. These decisions must have a vivid effect on the development of the company, whilst improving the products and services it provides. The tangible and intangible factors that affect the selection process are clarified in Table (2).

Table (2) : Intangible Factors Influencing Technology Selection (Tam, C.Y. 1996, Tummala VMR 1994)

Intangible Factors
Technical & Operational factors
Technical features/characteristics
System reliability/Availability
System performance
System capacity
Upgradability on HW and SW
System redundancy
Future technology development
Fault diagnosis capabilities
System security features
Ease of operations
Performance monitoring capabilities
Billing flexibility
Compliance with international standards
Vendors factors
Quality of support services
Supplier's problem solving capability
Supplier's expertise
Delivery lead time
Vendor's experience in related products
Vendor's reputation

Table (3): Tangible Factors Influencing Technology Selection (Tam, C.Y. 1996 , Tummala VMR 1994)

Tangible Factors- Cost Factors
Capital investment
Unit cost
Operating cost
Maintenance cost
Cost of network management system
Cost of support services

3. Acquisition of technologies that have been selected. Example processes include internal research and development, Joint Ventures, Organizational Change, Project Management, Licensing, corporate mergers and acquisitions, technology transfer, technology insertion.

4. Protection of knowledge and expertise. Processes include patenting, contracts, risk assessment, copyrights, staff retention, security management.

5. Exploitation of technologies. Example processes include process improvements, licensing, new product development, and supply chain management.

In order to survive in a fierce market, businesses must apply the protection of technology and information systems.

Technology management (TM) is addressed from the viewpoint of the dynamic capabilities theory in the study "Understanding technology management as a dynamic capability". Here the writers stress the importance of catching and controlling the opportunities that technology presents and, with effective technology management, convert them into value, given that technological advances are always creating new challenges, opportunities, services and products. This approach requires the business to understand and engage with technology management and its dynamic natures.

In order to explain how the company clarifies its ability to change, shape, redirect and integrate its present primary abilities; creates and allocates its resources; forms strategies to meet the constraints of a changing environment and limited time; explains how resources can be developed and utilized for each technology management activity; explains how it uses its resources for development and innovation over time; a dynamic technology management framework is proposed and illustrated in the following case study. The framework explored technology management activities in a wide business context (Teece, 2000).

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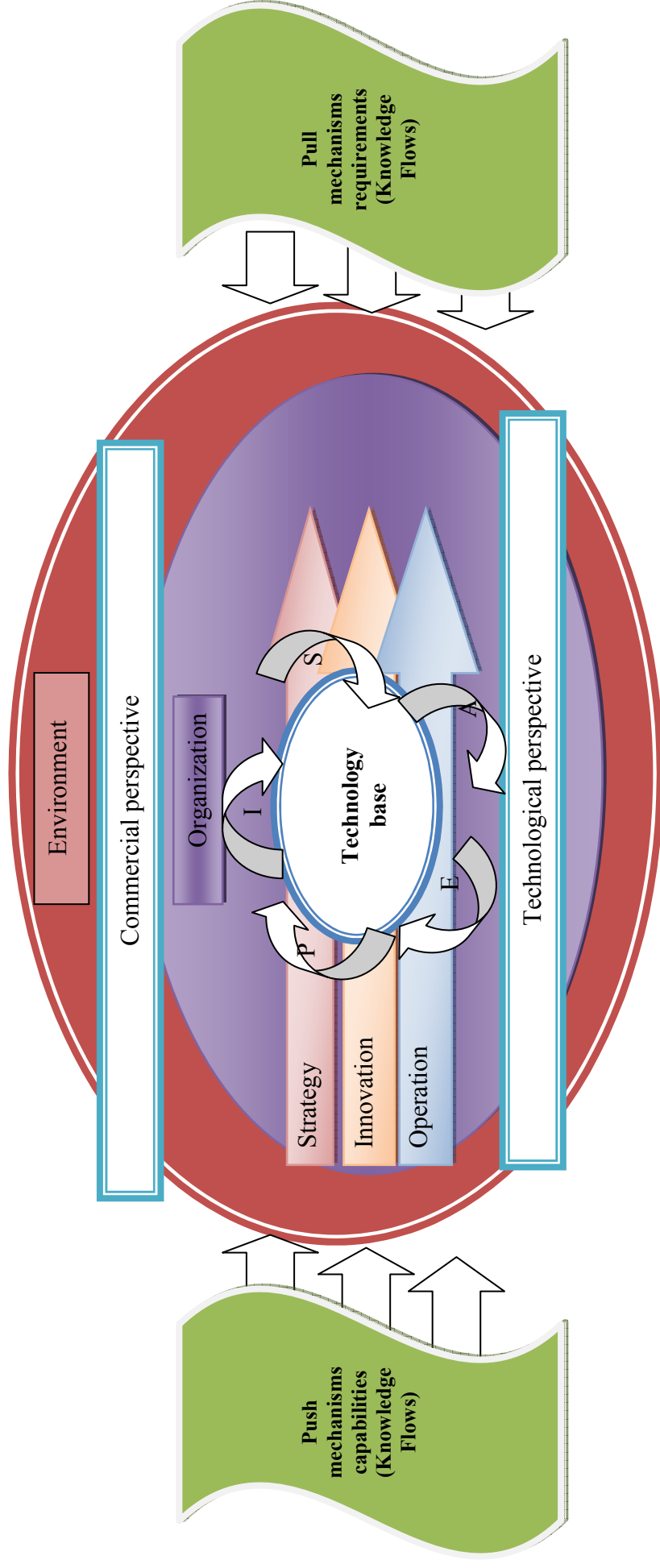
Figure (2-3): Technology management framework (Phaal,2004)

Other perspectives of TM activities were addressed in relation to business processes; in order to understand technological innovation a TM framework was created.

(Phaal, 2004) combined two sets of business process in his TM framework which have major roles and effects on effective TM; see Figure 2-3. These business processes were perceived and tested. The first set consists of primary business processes, such as innovation and operation processes, and strategy. The second set has five TM activities defined by Gregory as (identification, selection, acquisition, development, exploitation and protection of technologies). Gregory 1995

Gregory consolidated and integrated the two sets of primary business processed with each other, along with the 5 supporting TM activities he developed, by utilizing the flow of knowledge between technological functions and business functions, and by focusing on the equilibrium between the technology "push" and the market "pull".

2.2.5 Technology strategy

By understanding the company's strategy and the importance of relations of technologies to the business's competitive strategy, technology must be complied with. Also, during the value chain activities, technology must be correlated to the firm's strategy on processes, products and services. (Porter 1985, Meyer & Lehnerd 1997, Cooper.1998, Burgelman. 2001, Schilling 2008, Dodgson. 2008).

Burgelman (2001) states that as a root of the overall strategy, technology strategy is focused on linking the business's competitive strategies with technology. The successful integration of all areas of technological innovation and management is crucial in this regard to form a coherent entity. "Technology strategy comprises of the definition, development and use of those technological competencies that constitute the company's competitive advantage" (Dodgson, 2008).

During the value chain activities, the business's strategy on processes, services and products must be tied to technology. The connection of technology to the business's long term commercial plans or "strategy", means the significance and impact of technology on the business's competitive strategy must be taken into account.

Companies must be able to recognize events that may cause disruption, and be able to assess the dynamics of the life-cycle of the technologies they use, or may use at a later date, when businesses acknowledge the importance of successfully countering changes in technology.

So, the traits and abilities of technology must be evaluated, leveraged and developed across the business according to the business's services or products, its business strategy and its technology.

"Technology strategy serves as the basis for business strategy and competitive advantage and that's why technology strategy is one of the key elements in strategic technology management." (Burgelman, 2001).

Technology strategy gives us the answers to many questions such as:

- How much should we invest in technology development

- How should we organize TM and Technology development

- How can we introduce, as embedded in product, technology to the market

- Which technologies can be used?

- In relation to competitive advantage, which technologies, competences and capabilities are necessary?

- What is the buy or make of strategy?

"The scope and importance of a technology strategy is often recognized in companies, but the existence of an explicit technology strategy varies even in high technology companies" (Kropsu-Vehkaperä . 2009).

"Factors shaping the technology strategy comprise of internal and external integrative and generative forces. These forces are in interaction with organizational and industry context, strategic actions and technology evolution" (Burgelman, 2001). The determining factors of technology strategy are shown in Figure 2-4

Figure (2-4): Determinants of technology strategy.

Technology evolution, life-cycles, competence building, the destruction of technological disruptions, and maturity affects the technical abilities, and competitive advantage of a business (Rothaermel & Hill 2005). In addition, dominant designs, industry structures and complementary assets' availability, intellectual property rights and their protection, and standards have a significant impact on the followed technology strategy and the relative attractiveness of the business (Utterback & Abernathy 1975).

Strategic actions aimed at overcoming internal inaction, and to respond to external signs about commercial opportunities and technological evolution. In order to respond to the exploitation of opportunities contained in strategies or new opportunities that require modifications to strategy, organizational context deals with management challenges.

2.3 Technology Identification Process:

Identifying technology needs is one of the many steps in a Strategic Technology Planning, itself a tool of Technology Management is the

procedure of technology identification. It embodies a methodical approach of surveying all available technologies that may be of significance to the company.

Actually, as part of a larger procedure called Technology Management, private businesses have developed and used methods of identifying technology needs. The primary aim of TM is to increase competitiveness by creating new products or services or processes, improving current ones, working on patents, innovation and reducing costs.

Roussel (1991), like many other management scientist, stresses the value of linking business strategy and long term plans with technology needs identification. Applying this idea, to a service sector, for example the telecommunications sector, a business must articulate its strategic objectives in relation to what goods and services it should provide to the different parts of the population. Brockhoff (1998). Investigates in detail the relationship between and TM and strategy.

Technological Identification will ideally occur simultaneously in two different ways:

1. Appraisal and analysis of the processes of production for a good or service, noting opportunities for improvements that lend itself to future research projects. (Vasconcellos, 1990).

2. Assessing the technological and scientific trends that can facilitate us eradicating risk or modifying production methodologies Gregory (1995) states that there are many procedures needed to source the technology needed now or later by a business. These include

- Technology road mapping

- Technology forecasting

- Technology intelligence

- Technology scanning & monitoring
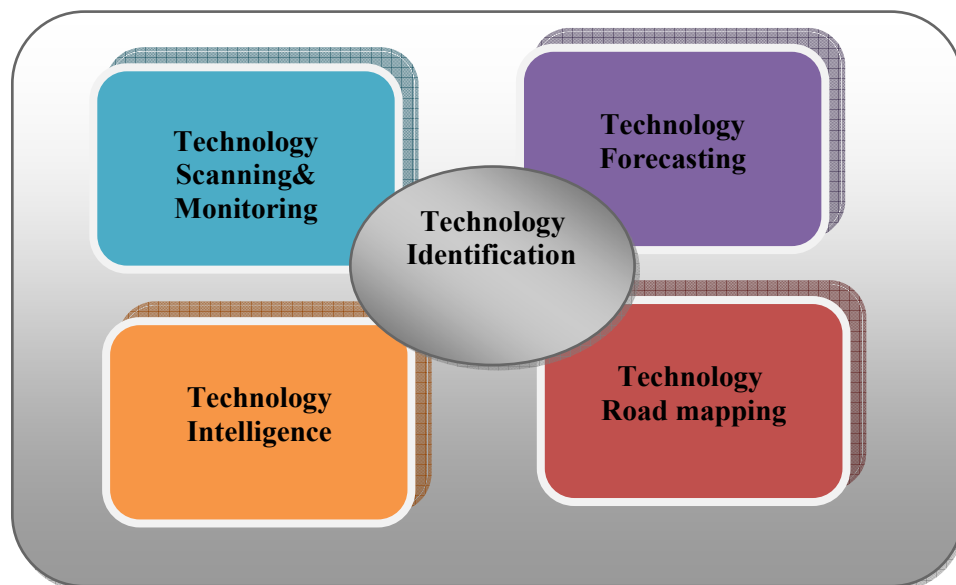
Figure (2-5): Technology identification elements (Gregory; 1995)

Businesses should capitalize on the intelligence of technology and avail of market surveys so as to assess the business's technological wants, or ones that may be of significance to the company. Businesses should stay

abreast of advances in technology that are relevant to it. Note that the activity should not be carried out nonchalantly. Businesses must develop activities relating to technology intelligence internally, so that systematically, technology identification can be carried out, qualified candidates should be assigned these duties, and data obtained from these procedures must be assessed and conveyed to all relevant commercial departments.

Input factors from the outside environment should support the process of identification. This includes data on clients and competitors, surveying the science base and other such inputs. The identification of these technologies can contribute to answering questions such as:

1. How the company's technological needs are monitored?

2. How does the company monitor technological developments and the technologies owned by competitors?

3. How can we introduce, as embedded in product, technology to the market

4. Which technologies can be used?

5. In relation to competitive advantage, which technologies, competences and capabilities are necessary?

2.3.1 Technology Forecasting (TF):

2.3.1.1 Technology Forecasting Concept:

Technology forecast (TF), generally, is related to systematic and structured attempts to foresee and comprehend the potential rate, traits, direction, and impact of changes in technology, especially use, adoption and innovation.

A technological forecast consists of four elements (Martino, 1983)

1. The time of the forecast or the future date when the forecast is to be realized.
2. The technology being forecast.
3. The characteristics of the technology or the functional capabilities of the technology and a statement about probability.

We can define the term forecasting as tool of planning that aids management in its efforts to deal with an uncertain future, placing great weight on past and present information to predict future trends.

Bright (1979) "Technology forecasting is a quantified statement of the timing, the character or the degree of change in technical parameters and attributes in the design, production and application of devices, materials and processes, arrived at through a specified system of reasoning."

There are myriad forms of overlapping TF developments and their effects, including roadmapping, foresight, technology intelligence, forecasting and assessment. To date little systematic focus is paid to conceptual development of the entire field.

Since 2003, the Technology Futures Analysis Methods Working Group1 (TFAMWG), has tried to create a structure with which it can further the procedures and methods used in TFA (Technology Futures Analysis). Such overlapping forms can be articulated as:

• Technical intelligence and competitive intelligence (converting that information into usable intelligence).

• Technology forecasting (anticipating the direction and pace of changes).

• Technology foresight, also national and regional foresight (effecting development strategy, often involving participatory mechanisms).

• Technology monitoring, technology watch, technology alerts (gathering and interpreting information).

• Technology roadmapping (relating anticipated advances in technologies and products to generate plans).

2.3.1.2 The necessary for and the various Purpose of TF:

Critical decisions are informed by the assessment of emerging technologies and their inherent impact. These range from an individual organization (e.g., a company) to a multinational level (e.g., the European Union). Big businesses need TF in its many forms in order to

- Forecast new product development,

- Form strategic decisions on technology licensing, joint ventures, and so forth.

- Focus on R&D,

Businesses of a smaller size may also rely on innovations in technology to survive. In such cases, in order to plan the adoption of dissemination of innovations TF procedures are undertook, where boundaries like advertising response rate and adoption imitation rate can be measured.

2.3.1.3 TF Methods:

There are many TF (technologies forecasting) methods, which can be organized into 9 categories: Expert Opinion, Trend Analysis, Monitoring & Intelligence, Modeling & Simulation, Scenarios, Statistical, Descriptive, Creativity, and Valuing/Decision/Economics Methods. Table-4 summarizes the most common methods of technology forecasting.

Table (4): Technology forecasting method

Forecasting methods	
1) Expert Opinion • **Delphi (iterative survey)** • **Focus Groups [panels, workshops]** • **Interviews** • **Participatory Techniques**	**2) Trend Analysis** • Trend Extrapolation [Growth Curve Fitting] • Trend Impact Analysis • Precursor Analysis • Long Wave Analysis
3) Monitoring and Intelligence Methods • **Monitoring [environmental scanning, technology watch]** • **Bibliometrics [research profiling; patent analysis, text mining]**	**4) Statistical Methods** • Correlation Analysis • Demographics • Cross Impact Analysis • Risk Analysis • Bibliometrics [research profiling; patent analysis, text mining]
5) Modeling and Simulation • **Agent Modeling** • **Cross Impact Analysis** • **Sustainability Analysis [life cycle analysis]** • **Causal Models** • **Diffusion Modeling** • **Complex Adaptive System Modeling (CAS) [Chaos] 6** • **Systems Simulation [System Dynamics, KSIM]** • **Technological Substitution** • **Scenario-simulation [gaming; interactive scenarios]**	**6) Scenarios** • Scenarios [scenarios with consistency checks; scenario management] • Scenario-simulation [gaming; interactive scenarios] • Field Anomaly Relaxation Method [FAR]
7) Valuing/Decision/Economics Methods • **Relevance Trees [futures wheel]** • **Action [options] Analysis** • **Cost-benefit analysis** • **Decision analysis [utility analyses]** • **Economic base modeling [input-output analysis]**	**9) Creativity** • Brainstorming [brainwriting; nominal group process (NGP)] • Creativity Workshops [future workshops] • TRIZ • Vision Generation • Science Fiction Analysis

Now with the most popular methods we undertake a short assessment.

- **Expert Opinion:**

In this category methods include planning or the comprehension of technological development by way of considerable dialogue with subject matter experts. The Delphi Method represents the most popular method in this category. It links expert opinions related to the probability of executing the proposed technology along with expert opinions related to the proposed development time into a single position.

With this method, a series of individual inquiries is followed by data and viewpoint feedback taken from the assessment of the data from the first responses. This feedback, inclusive of the reasoning and/or logic to each expert's opinion, facilitates different experts to reassess their forecast after reflection of the new information. A single acceptable forecast is typically agreed upon after several rounds of this process (Levary 1995).

- **Trend Analysis:**

This deals with prediction, by way of the continuation of historical and quantitative data into the future. It is a general term that embodies economic forecasting models and techniques such as exponential smoothing, regression, Box-Jenkins' and growth curve fitting.

Several separate stages generally form the life cycle of technology. Usually the stages will be made up of the first adoption stage, a growth stage, a maturity stage and a declining final stage. The boundary estimate of a technology's life cycle curve forms the basis of growth curve forecasting. The growth curve forecasting method is beneficial in that it can gauge the decline at each stage of the life cycle or the upper limit of the level of technology growth.

The Fischer-Pry Analysis is one method of growth curve forecasting. This method is beneficial in its ability to forecast when the technology under examination will reach a certain life cycle stage.

- **Statistical Methods:**

Correlation Analysis and Bibliometrics represent the most popular Statistical methods. To forecast the development trends of new technologies correlation analysis is used. This is when the development trends of this new technology display similar traits to present technologies. Use of this method presupposes that data regarding the development patterns of the existing technologies are available (Phillips, 2005).

- **Valuing/Decision/Economics Methods:**

"Relevance tree approach" represents the most popular method in this family. Relevance tree is a normative approach to TF (Twiss 1992a).

Here the aims of the technology in question are decomposed in a tree shape format into bottom level aims and objectives. Like this, we can identify the hierarchical nature of development in technology and its associated probabilities of occurrence. We must then gauge the chances of achieving these aims and objectives at all of the levels. We can then predict the probability of achieving these aims and objectives using these probabilities.

2.3.2 Technology Scanning and Monitoring:

As predicting and monitoring the progression of technologies is crucial for policy and strategy formulating, technology monitoring is essential for corporations and governments. Varying sources of data are used in monitoring in order to create the atmosphere for forecasting, that can draw on information to the prediction and planning procedures, and to improve and renew the expectations on which senior decisions are made.

According to Coates (1986), Monitoring is "to watch, observe, check, and keep up with developments, usually in a well-defined area of interest for a very specific purpose." Porter and Detampel (1995) also noted that "monitoring is akin to 'environmental scanning' and 'issues management' efforts to identify emerging developments likely to affect an organization over the coming few years."

(Bright, 1970) states that the "monitoring of External Technologies" as "To anticipate innovation, the political, social, and other factors influencing its progress must be systematically monitored"

Some researchers have stated that technology represents a systematic method of characterizing and adhering to technology trends. Porter defines it as the task of "cataloguing, characterizing, and interpreting technology development activities" (Porter A. 2005). Lichtenthaler uses the definition of routine tracking of designated science and technology topics of interest to detect trends (Lichtenthaler, 2006).

(Bright, 1970) states that technology monitoring should include many activities and not simply "scanning" and gathering data processes. Monitoring includes several activities such as :

1. Checking the environment for signs or signals that could be beneficial in identifying technological advances.

2. Identifying the possible ramifications and consequence of signs.

3. Picking the parameters, policies, events, and decision that should be followed to ensure the correct pace and approach of technology and the impact of using it.

4. The creation of a conclusion based on assessing the modifications in these viewings and observations.

To help identify technological change (Utterback & Brown,1972) encourage using the approach of "signals", or indicators. Utterback and

Brown say that this methodology involves two principal activities: first, in emergent stages of a technology to identify "signals" of change and second, collecting data on suitable parameters to predict the speed of progression and distinguish the plausible effect of technology on the business's commerce.

From the perspective of technology intelligence, monitoring is understood as a search whilst surveying is understood as an indirect search. (Lichtenthaler, 2006) explains technology monitoring as a directed, inside-out, outlook, which is most concerned with the attainment of data on known and singled out technologies, all the while surveying is understood to be indirect, outside-in, search which concentrates on looking for updates technological progressions and technologies that are not presently not known to the business. Figure 2-6 demonstrates the viewpoint of technology intelligence.
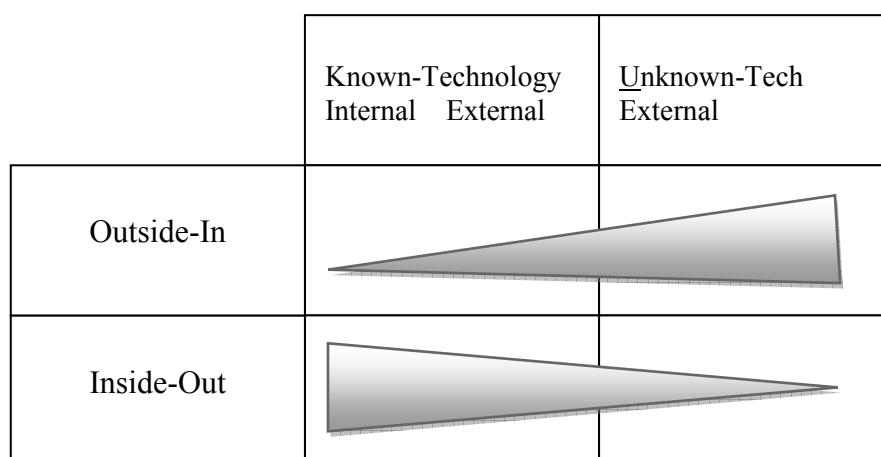
Figure (2-6): Perspective of technology intelligence

Porter et al (1991) suggest general four steps for the monitoring process:

Note that one should adapt their set of steps to their own particular wants. Generally, the following steps work well:

1.   Identify the monitoring aims and focus

2.   Explain the technology and lay out the relevant context

3.   Modify a relevant monitoring strategy

4.   Understand and communicate results

2.3.3 Technology Roadmapping:

As far as effective technology planning and cooperation for businesses and their industries, technology roadmapping is a particularly relevant tool. It represents a particular method for technology planning, which works inside a broader framework of planning activities. In order to ensure that the management of technology benefits the business, we are obligated to implement an effective framework of processes and systems that will guarantee that the needs of the company are aligned with the internal technological resources.

Some methods have been created to assist TM and the planning of one of these methods is (TRM) Technology Road Mapping. TRM, has become known for its ability as a management technique to support innovation and strategy at all levels from firm to sector to national. It consists of a structure for tying together technology and businesses. And as such it is widely used and adopted in varying sectors so as to support the

development implementation, and communication of technology and business strategy (Barker and Smith, 1995;Willyard and McClees, 1987,).

"Technology Roadmapping" (TRM) normally refers to many types of prediction studies such as visions and detailed expectations of future possible technological advancements, goods or environments [Da Costa 2003].

Technology roadmap (TRM) is a management tool used to aid strategic and long-term R&D planning. It is an approach that relies on needs that are utilized to understand and convey the various connections between organizational aims, technological resources and the evolving environment, and is adopted to aid technological investment and planning by singling out key facilitating technologies and gaps in technology in an effort to leverage R&D investments.

TRM is adopted in many environments, including physical and service product planning (Kirchhoff 1998), development of product family tree (Groenveld, 1997), and program planning (Sandia National Laboratories).

(Albright and Kappel, 2003) explain that TRMs in a business environment are used to clarify the plan for the progression of a good, connecting commercial strategy to the development of the product features. The primary role of TRM is to aid technology management and planning

(Phaal and Farrukh , 2004). It can show a structure to aid planning and the coordination of technology developments.

TRMs can embody many forms, from the two extremes of technology push (divergent and looking for opportunities) and market pull (aiming for customer defined product). The most typical method is shown in the general form suggested by European Industrial Research Management Association (EIRMA, 1997). The general roadmap shown in pictorial time-based charts that consist of multi layers and generally have includes the technological and commercial viewpoints.

Figure 2-7 shows a generic technology roadmap explaining how technology can become aligned to business strategy, good and service developments, and market opportunities.
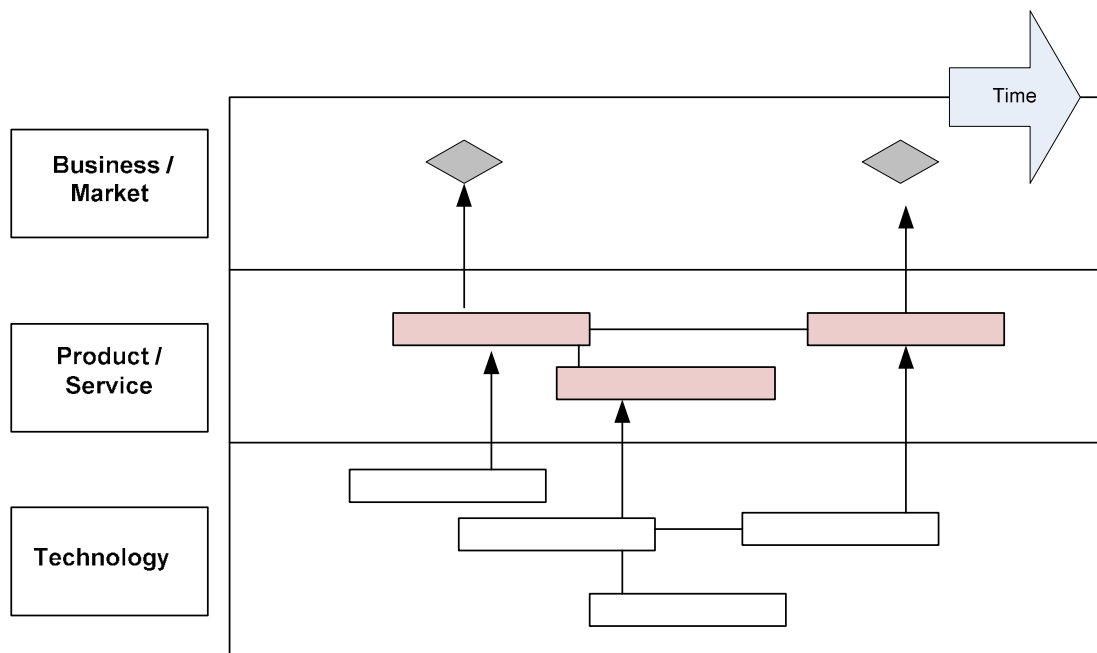
Figure (2-7): A generic technology roadmap ((Phaal. 2004)

At levels such as individual, business and sector levels, TRM comprises many prospective benefits and uses. The primary advantage of TRM is the data that it provides facilitate improved technology investment decisions. This is achieved by singling out key gaps in technology or technologies that must be remedied to ensure future good performance targets are met. Some benefits of TRM can be listed in the following points:

1. It can facilitate the development of an understanding about a group of needs and the technologies needed to meet those needs.

2. It can offer a structure to aid planning and the coordination of technology developments both within a company or an entire industry.

3. From marketing viewpoint, a TRM can demonstrate that a business comprehends client wants and has access to or is forming the technologies to meet their needs.

4. It offers a method that aid experts to predict and forecast technology developments in specific areas.

TRMs obviously hold significant potential to help the progression and implementation of business, good and technology strategy, offering businesses with the data, systems and structure to create them.

2.3.4 Technology Intelligence:

Current research on technology management have stressed the importance of staying informed of technological advances by adopting technology intelligence (TI) strategies (Kerr, Mortara et al. 2006) .Technology Intelligence (TI) can be defined as the activity that facilitates firms to single out the technological opportunities and obstacles that could have an effect the future progression and existence of their company.

The Centre for Technology Management has defined 'technology intelligence' as "the capture and delivery of technological information as part of the process whereby an organization develops an awareness of technological threats and opportunities." (Kerr, 2006). It strives to capture and diffuse the technological data needed for decision-making and strategic planning.

Understanding the importance of these points, many companies have adopted and adapted Technology Intelligence (TI) systems, created to capture data about emerging technologies and trends and to produce it in a useful way for decision makers.

Intelligence is derived from external outlets, but it may also be held internally in the organization - explicitly or implicitly – in the eventuality that was acquired by another body.

Companies must source such data swiftly and with relative ease, as well as getting the data they require from external sources.

The researchers (Letizia Mortara, Clive Kerr, Rob Phaal and David Probert) studied in a variety of sectors, 14 UK technology-based firms reflecting on the different approaches the firms were implementing to collate information, identify their pros and cons and determining useful ways to deal with typical obstacles, and then formed a three-level model of attaining technology intelligence comprising the:

- Framework,

- System,

- Process.

The basis of this model was to identify how companies stay abreast of the most current technological advancements. In these 14 technology-based firms, the model was tested through case studies of technology intelligence systems.

- **Disruptive technology:**

Not only can technologies be adopted to aid the business's organizational processes, but it may also offer the base for competitive advantage. Technologies facilitate a company becoming more competitive, guaranteeing more business, producing at a higher rate, keeping clients content and becoming more efficient.

Christensen and Bower (1995) define disruptive technology as "innovations that create an entirely new market through the introduction of a new kind of product or service" .This definition suggest that disruptive technology is an invention that leads to a different way of doing business, how people work, and how a company operates its business. Kassicieh (2002) has defined disruptive technologies as "scientific discoveries that break through the usual product/technology capabilities and provide a basis for a new competitive paradigm".

Disruptive technologies offer further obstacles and adaptations to the organization which could be realized as benefits to the organization. However the capacity of disruptive technologies to modify the business landscape, upon entry into the industry marketplace, increased (Patki, 2006). Organization can use disruptive technology to attain a competitive advantage or suffer the risk of losing clients altogether through their unwillingness to utilize the updates technology. Disruptive technologies have the capacity to form a new market and consequently render other industries redundant (Tsui, 2001).

In order to fully comprehend disruptive technology, the concept "sustaining technologies" has to be assessed. Christensen (2000) describes sustaining technologies as technologies that "foster improved product performance".

This has implications that existing products can be incremental in nature."Sustaining technologies create innovations that are modification of, or improvement to, or replacement of existing products" currently used within the firm (Walsh& Kirchhoff, 2000).Walsh& Kirchhoff also use the term "evolutionary technology" as another word for sustaining technology.

Walsh and Kirchhoff (2000) said that throughout their research it was tricky to single out a disruptive technology before the implementation stage and before being used by different users. It is sometimes tough to forecast what impact disruptive technology will have on the sector and which sector the disruptive technology will enter.

2.4 Technology selection:

2.4.1 Technology selection definition:

It us up to manager to formulate decisions in relation to applicable technologies so that the optimal possible outcomes are achieved on the investment in technology. Updated technology may provide chances for new businesses and product differentiation. So, the informed choice of modern technology is a more difficult decision that managers in businesses must face and make.

The selection of technology is in relation to picking the correct and optimal technology from a selection of relevant choices. Gregory (1995) defines technology selection as 'involving the choice of technologies that

should be supported and promoted within the organization'. He deems technology selection to be concerned with R&D management, competence and capabilities, and new product introduction.

Based on his definition, Lamb and Gregory (1997) suggest that technology selection involves 'gathering information from various sources about the alternatives, and the evaluation of alternatives against each other or some set of criteria'. They say that evaluation is in relation to 'the notions of cost, benefit, and risk'. Dussauge (1997) define technology selection process as 'identification and selection of new or additional technologies which the firm seeks to master' so he considers in his definition two process "identification" and "selection" as one process called "Technology selection". In contrast, Gregory (1995) separates the 'identification' and 'selection' phases where the former is in relation to collating alternatives and the latter is in relation to deciding on an alternative.

Stacey and Ashton (1990) explain technology selection as a way of prioritizing technological investment options, meaning that the selection of technology must acknowledge the commercial and technological threats implicit in meeting an organizational goal. This broader technological and commercial context of technology selection is also held by Matthews (1992), who sees it as a primary part of technology strategy development.

A primary theme in these explanations is that technology selection is a 'process' which is connected to other commercial processes, and is linked with the more general technological, organizational, and business environment.

2.4.2 The Importance of Technology Selection:

Industrial managers sometimes encounter the problem of choosing a single most suitable technology from a group of competing choices. The quick development of technologies, combined with their escalating difficulty and variety, makes the job of technology selection tough. Modern methods of deciding technology selection decision are usually thinly concentrated on appraisal of the financial feasibility of technology choices, or generic investment adherence factors. Often, the selection procedures are in relation to broadly defined decision support tools which are not fully modified for technology selection.

The relevance of precise technology selection is crucial for the existence of any business. This is why a informative approach or systematic procedure is necessary to explain how to guarantee all necessary data has been deliberated upon when formulating this key decision.

Reflections on the selection of other technology choices and the distribution of resources must be sourced from all levels of the business. Yap and Souder (1993), say that effective communication between various experts is crucial for two reasons. First, the more each body is informed

about technologies, the greater the chance that the bodies will be keen to support the selection decision. Secondly, transparent communication gives rise to the flow of informed viewpoints and subjective data is crucial to the right technology selection.

Arbel and Shapira (1986) say that there is a desire for a systematic appraisal of factors intrinsic in the selection, in relation to the specifications and barometers that lead to the assessment and picking of the best choice. Their selection model concentrates on two large families of issues: benefit and cost.

Piippo and Tuominen (1990) stress the match of alternative option to the abilities and approaches of businesses and risks, as the primary reasons behind the selection, as well as to benefits and costs.

2.4.3 AHP- A helpful tool used in selection process

Analytical Hierarchical Process (AHP) is a decision-making method that can be beneficial in explaining the typical decision operation by assessing a difficult problem into a multi-level hierarchical structure of aims, specifications, sub- specifications, and other alternatives. The AHP was introduced by (Saaty, 1980) as a way of decomposing a difficulty, unstructured predicament into its composing components, putting these parts or judgments on the relative significance of each variable, and collating the opinions to determine which variables are of the highest priority and must be acted upon to have an effect on the result of the

situation Saaty (1990). A problem is put into a hierarchical structure with level-I reflecting the overall aim or concentration of the decision. Level-II contains criteria or specifications for the decision, level-III contains sub-criteria, and level-IV contains the decision options.

The prioritization process is achieved by giving a number from a scale created by (Saaty, 1990) to show the significance of the specifications. A matrix with pair-wise comparisons of these traits offers the means for estimation.

AHP can also be utilized in forming decisions that are difficult, lacking in structure, and have multiple traits. (Partovi,1994). The AHP is generally easy to use and comprehend. This method uses qualitative and quantitative specifications. An assessment of the selection literature demonstrates that the AHP approach to be one of the most typically adopted methods being used today. AHP is a particularly good method for assigning rank to alternatives when multiple specifications and sub specifications are already in the decision-making process. Figure 2-9 clarifies the construction of the "Analytic Hierarchy Process"
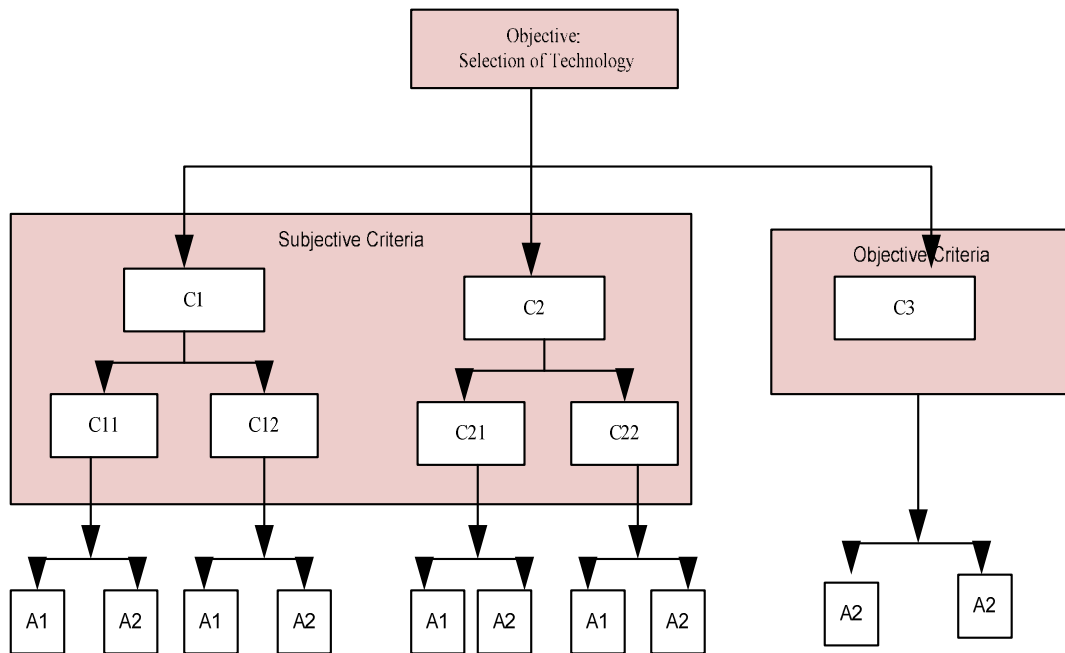
Figure (2-8): Analytic Hierarchy Process (Saaty, 1980)

Chapter Three

Research Designed and Methodology

3. Research design and methodology:

Research is a structured investigation that used convenient and acceptable scientific methodology to solve problems and generate new knowledge that is generally applicable. Research design can be considered as the structure of research, that explains how all of the main parts of the research project ,the samples or groups, measures, and methods work together to try to address the central research questions. Research plays a very significant role in propose and finding solutions to the existing problems or in settle the problems in a better way.

Research is an ongoing and continuous process. Observations, interviews, questionnaire, surveys, case studies, content analysis, and cause and effect analysis are methods used to implement and carry out researches. Upon the objectives and purposes of the research, the researcher can choose the methodology and practical way of doing the research. Such as for pure science, experimental methods are more useful than other methods. For social science, behavioral research, observation and in-depth study methods are mostly used.

This chapter presents the research methodology adopted by the researcher including, research strategy, research objective, methods adopted for data gathering and analysis, and research validity and reliability.

3.1 Research approach:

There are several types of research which are described in many literature reviews. Kumar (1999) classifies research from three perspectives (application, objectives, and inquiry mode employed. Figure 3-1 illustrates the research topology from three perspectives; each one will be discussed in brief:
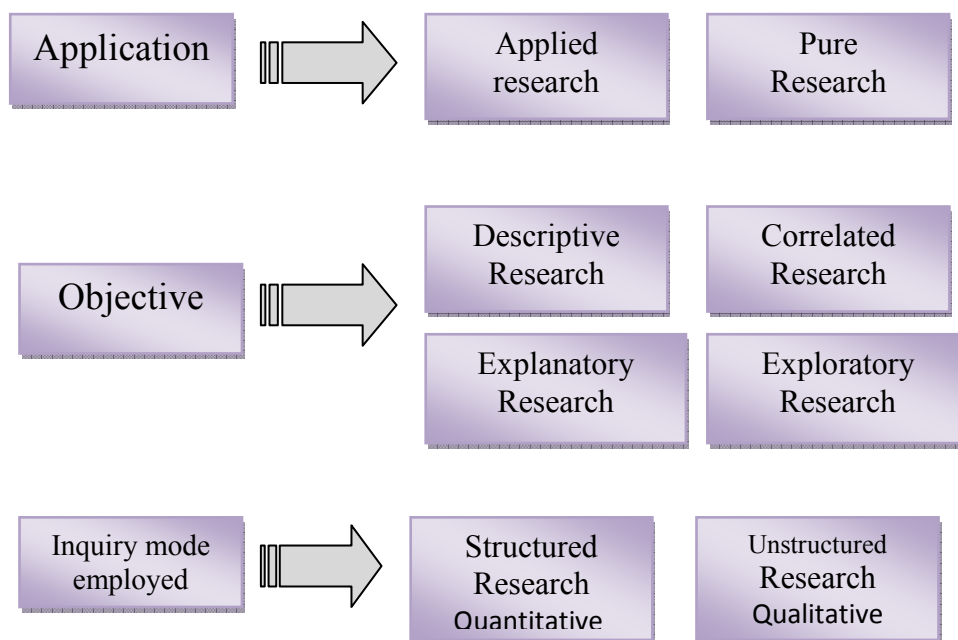
Figure (3-1): Types of research in relation to the viewpoint (Kumar 1999)

1. Application:

From the point of view of application, there are two broad categories of research:

- Pure research and

- Applied research.

Pure research involves developing and testing theories and hypotheses that are intellectually challenging to the researcher but may or may not have practical application at the present time or in the future. The knowledge produced through pure research is sought in order to add to the existing body of research methods.

Applied research is done to solve specific, practical questions; for policy formulation, administration and understanding of a phenomenon. It can be exploratory, but is usually descriptive.

2. Objectives:

From the viewpoint of objectives, a research can be classified as

- Descriptive

- Correlation

- Explanatory

- Exploratory

Descriptive research attempts to describe systematically a situation, problem, phenomenon, service or program, such as describing the type of services provided by an organization or provides information about , living condition of a community, or describes attitudes towards an issue.

Correlation research attempts to discover or establish the existence of a relationship/ interdependence between two or more aspects of a situation.

Explanatory research attempts to clarify why and how there is a relationship between two or more aspects of a situation or phenomenon (Yin 2002).

Exploratory research is undertaken to investigate the possibilities of a particular research study and also called (feasibility study / pilot study).

3. Inquiry Mode:

Inquiry mode viewpoint refers to the perspective of the information sought and include two type of research, structured approach (quantitative approach) and unstructured approach (qualitative approach).In this type of research the purpose of the research study should be identified, the variables, and analysis of information is measured.

The structured approach is usually classified as quantitative research if there is quantitative method to collect data and information and then analyze it to measure the value of the variation. The unstructured approach is usually classified as qualitative research, the research study considered to

be qualitative if the purpose of the research study is to forming and determining the research process, objectives, design, sample, and questions that should be asked and exploring the nature of a problem, issue or phenomenon without quantifying it.

Qualitative research is a type of scientific research that aims to:

• Attempt to answer a question

• Systematically uses a predefined set of procedures to answer the question

• Collects evidence

• Produces findings that were not determined in advance

• Produces findings that are applicable beyond the immediate boundaries of the study

Additionally, it seeks to understand a given research problem or topic from the perspectives of the local population it involves. Qualitative research is especially effective in obtaining culturally specific information about the values, opinions, behaviors, and social contexts of particular populations.

The three most common type of qualitative methods are: participant observation, in-depth interviews, and focus groups. Each method is particularly suited for obtaining a specific type of data.

- Participant observation is appropriate for collecting data on naturally occurring behaviors in their usual contexts.

- In-depth interviews are optimal for collecting data on individuals' personal histories, perspectives, and experiences, particularly when sensitive topics are being explored.

- Focus groups are effective in eliciting data on the cultural norms of a group and in generating broad overviews of issues of concern to the cultural groups or subgroups represented.

The primary difference between qualitative methods and quantitative is summarized in their analytical objectives, the types of questions they pose, the types of data collection instruments they use, the forms of data they produce, the degree of flexibility built into study design. Table 5 shows the main difference between quantitative and qualitative method.

Table (5): Comparison of quantitative and qualitative research approaches (Bernard 1995)

	Quantitative	Qualitative
General framework	*Seek to confirm hypotheses about Phenomena	*Seek to explore phenomena
	* Instruments use more rigid style of eliciting and categorizing responses to questions	*Instruments use more flexible, iterative style of eliciting and categorizing responses to questions
	* Use highly structured methods such as questionnaires, surveys, and structured observation	*Use semi-structured methods such as in-depth interviews, focus groups, and participant observation
Analytical objectives	To quantify variation To predict causal relationships To describe characteristics of a population	To describe variation To describe and explain relationships To describe individual experiences To describe group norms
Question format	Closed-ended	Open-ended
Data format	Numerical (obtained by assigning numerical values to responses)	Textual (obtained from audiotapes, videotapes, and field notes)
Flexibility in study design	Study design is subject to statistical assumptions and condition	Study design is iterative, that is, data collection and research questions are adjusted according to what is learned

3.2 Research method applied in the thesis:

The research method with which this research is conducted should be consisting with the way a study is performed. In this research a case study approach was used. Case study have sufficient flexibility for some research

designs, since it allowing the researcher to retain the holistic characteristics of real-life events while investigating empirical events. It is concentrate on and gathers in depth information about a specific phenomena, group, community or event. It can provide detailed information about a particular subject that it would not be possible to get through another type of experimentation. Case study is best appropriate to considering the how and why questions. In general, a case study is an empirical inquiry which investigates a contemporary phenomenon within its real-life context

In this research a case study approach was used in order to examine and highlight how is one of the most important companies that depend entirely on the technology in the telecommunications sector identify and select its technology. The researcher hold interviews with concerned people, were approximately 12 interviews were conducted with senior supervisor, managers and also CTO and every interview was lasted for 15 minutes. In order to collect useful information in this area, the interview questions which are shown in (Appendix-A) has been formulated and the answers on the questions were reordered in notebook. On the other hand, observation methods have been adopted in this study, where in terms of my work within the company for nearly five years, I was watching how the process was performed in the company.

A qualitative research method that can be seen as a combination of the constructive approach and the case study approach has been used.

The constructive approach can be defined as problem solving through the construction of models, plans, organizational procedures, and generally involves the following steps (Kasanen, Lukka, & Siitonen, 1993):

1. Identify a practically relevant problem for a chosen organization and formulate research questions to be investigated.

2. Establish an overview of the technology identification and selection fields through studying literature studies.

3. Analyzing how the host company is currently working with technology management practice ;identification and selection

4. Use theoretical and empirical findings to construct a systematized framework for technology identification and selection

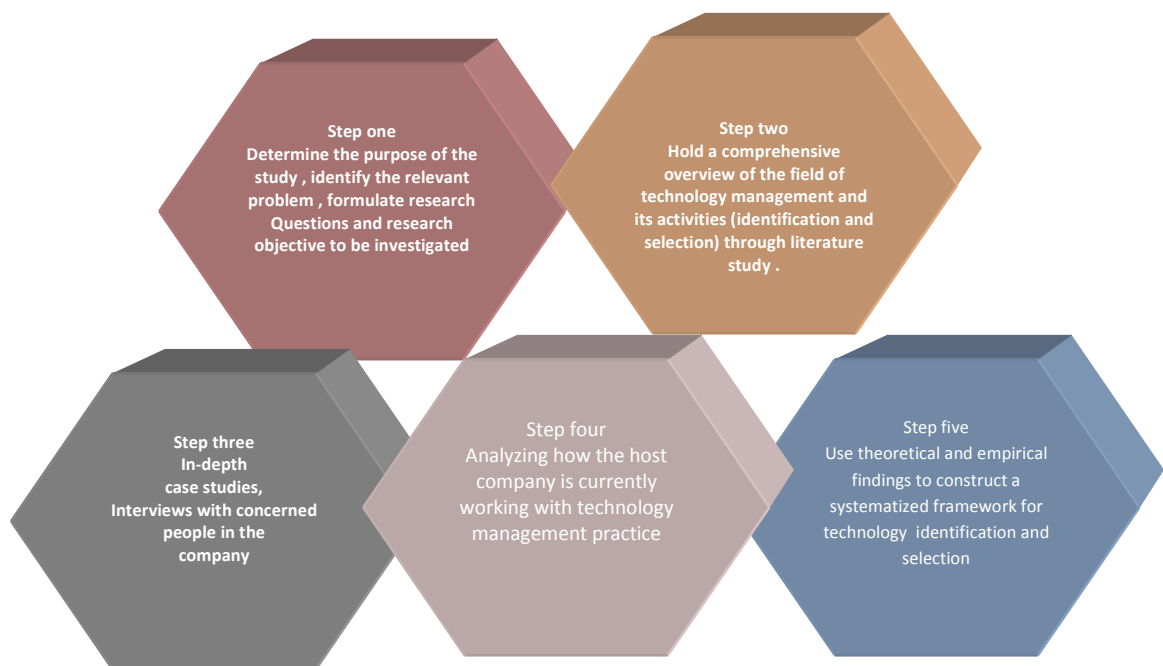The research methodology used can be summarized in Figure 3-2:

Figure (3-2): Research Procedure

- **Creating the Theoretical Overview of Technology identification and selection**

Performing a literature study is the basis of scientific research since it gives a direction and relevance for the research about to be performed (Andersen, 1994). The purpose of the literature study in this thesis was to get an overview of the field of technology identification and selection and how they could be done in a systematic way.

The theoretical framework was developed from the existing research based on an extensive literature study in the field. The literature fields that were studied are technology management, technology forecasting, technology identification technology selection, technology monitoring. Those were concepts that found out to be key areas in the field of technology identification and selection during the initial literature review.

(Denscombe.1998) points out a number of critical aspects to consider while reading various sources; authenticity, credibility and representativeness. The authenticity of the material should considered to be high and should be mainly collected from public libraries and highly accredited journals within the field of study. The credibility and representative should also be considered high, as multiple sources should be used.

- **Analysis of the Host Company's Current Technology Identification and selection Process:**

In a case study, it is important to realize the particular nature of the case that one is studying (Bryman & Bell, 2007). The step was trying to understand PALTEL's existing way of working with regard technology identification and selection and how it keeps track of technological development, threats, opportunities in the external environment . To get a broad picture of how all the different parts of the organization worked with this, over ten interviews were conducted with concerned managers ,directors and supervisors within the company. This gives a lot of valuable insights into the way of working with technology, and how the technology identification and selection could be improved.

- **Developing the Proposed Framework:**

The next step in the research process focused on constructing and describing a proposed framework for how telecom companies like PALTEL could work systematically with technology identification and selection. The proposed framework was built based on literature studies which made up the main source to find tools and frameworks that related to identification and selection of technologies ,in addition to the discussion that had been made with people inside the company for defining the scope of the research and the challenges that they were facing in identifying new technology.

3.3 Data Collection Tools:

Data Collection is an important subject for any type of research study. The accuracy of the collected data have a major impact on the study results and ultimately on the success of research. Two primary data collection tools were used in this research study, the first depend on interviews to collect the data and the other depends on the observation.

Interviews:

In-Depth Interviews include both individual interviews (e.g., one-on-one) as well as "group" interviews (including focus groups) .The data can be recorded in a variety of ways including audio recording, video recording or written notes. In interviews it is assumed that there is a questioner and one or more interviewees.

In this thesis a structured individual interview was designed and conducted with concerned people in an attempt to identify major technology management activities ;identification and selection themes applied in the company and draw conclusions based on the analysis of these specific themes. The structured interview questions were formulated (see Appendix-A) to answer the main research questions and the data were recorded in written notes since the company does not allow using the audio and video recording during the interviewing and only just taking information by writing notes.

Observation:

Sometimes, observation is considered as an effective way to collect data. By using this method, the researcher may choose to collect data through continuous observation or via set time periods depending on the project and research. The researcher may analyze and interpret the gathered data using the following mechanisms:

1. **Descriptive observations**: the researcher simply write down what he observe

2. **Inferential observations**: the researcher may write down an observation that is inferred by the subject's body language and behavior.

3. **Evaluative observation**: the researcher may make an inference and therefore a judgment from the behavior.

In this research a descriptive observation tool is used where the researcher receive the information by observing, and viewing the events pertinent to the study that is "how the company make the selection process for new technology and how they make assessment for it". The author of this thesis is currently one of PALTEL staff who worked in the company for nearly five years. This put him in an advantageous position to observe and be part of the organization as the case of action research.

Chapter Four

Technology identification and

selection in PALTEL telecom company

4.1 Introduction

The process of identification and selection of technology gains high importance in PALTEL company, since it is considered as the pillar on which the firm depends on in choosing the appropriate technology and systems.

By identifying and selecting the appropriate technology, the company will be able to cope with development in telecom sector, be able to offer the latest and up-to-date technology and services and will produce a high quality and enhanced services with a high quality and competitive prices.

This chapter comes to highlight the currently applied technology identification and selection framework in PALTEL Company and clarify its role in serving the company strategy; in addition it describes the phases, elements and directorates involved in the framework and responsibilities, roles of each one.

4.2 Overview of PALTEL Company:

PALTEL is the national telecommunications provider in Palestine. PALTEL was established at the outset of the Peace process in the Middle

East, and started its operations in Palestine in 1997 as a public shareholding company. PALTEL provided state of the art services to the Palestinian end users and customers.

It offers a range of services including local and international telephone services, internet, data communications, value - added services, Payphones, and next generation services, in addition to providing the backbone for other related telecom services. PALTEL, the fixed-line telecommunications service Provider in the PALTEL Group with service in the Gaza Strip and West Bank, also provides facilities and services to PAL TEL Group's mobile operator, Jawwal, and ISP (Hadara, cool net, CALL U, ASAL). PALTEL was able to achieve the highest standard in telecommunication services based on investment in modern technologies, telecom infrastructure and Human Resource development.

PALTEL, the fixed-line and internet service provider provides the following residential and business services:

- Voice services

- Frame Relay and Leased Line data services

- High Speed Internet (xDSL) and IP-based Virtual Private Networks ("VPNs") data services

- Prepaid card services

4.2.1 Mission and Vision of PALTEL Company:

"Since the establishment of PALTEL, the company strives to be at the front and maintains its survival strongly among competitors, and focused to reach the highest standards of advancement in serving its subscribers, so the company seeks to gain the confidence of the customers through providing them with the latest and up -to -date services in a timely manner and at affordable and cost effective levels. In addition; the company always aimed to realize good return on investments and assured that investor's expectations are met". www.paltel.ps

4.3 Technology Identification and Selection Framework Applied in PALTEL Company:

PALTEL has its own framework in identifying and selecting new technologies and services .The applied framework designed to fit with the business environment and take into account the limitations and constraints that will affect the decisions of using the technology either it is external factors outside the firm or internal factors inside the firm. The process of identifying and selecting new services and technologies lies mainly on the responsibility of "Business planning department" and "Technical Planning department". Figure 4-1 shows the general technology identification and selection process applied in the company
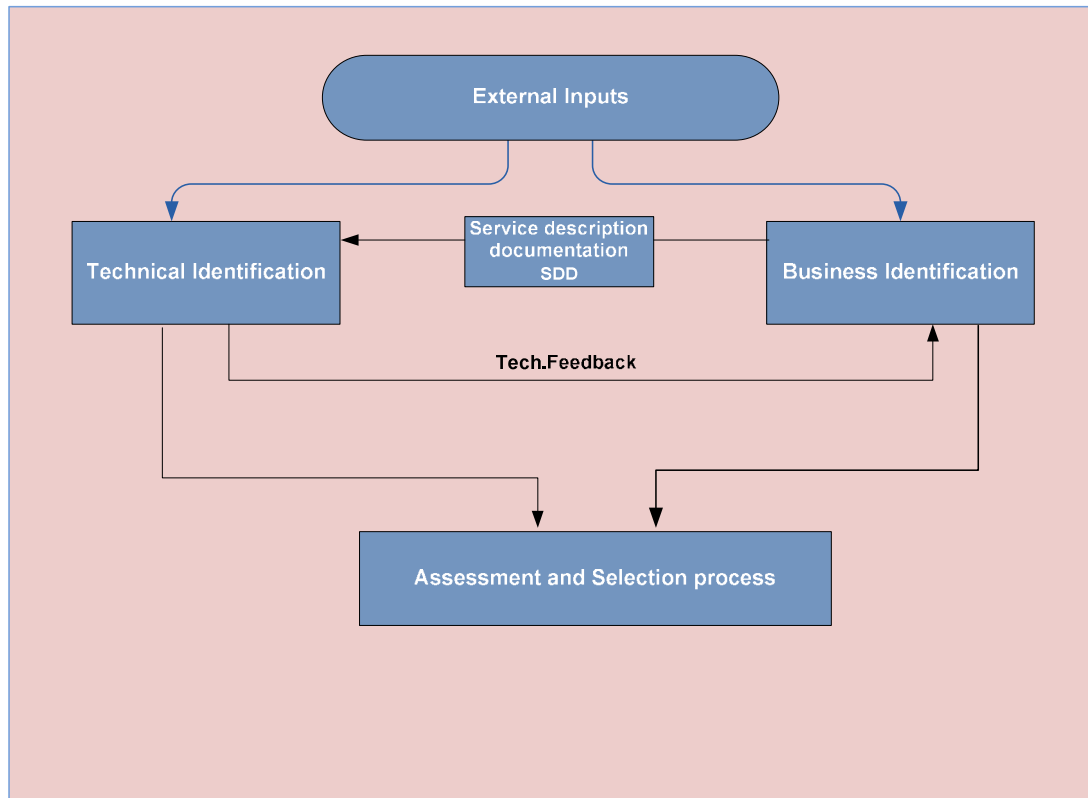
Figure (4-1): General technology identification and selection framework applied in PALTEL company

4.3.1 Technology Identification process:

Technology identification processes mainly focus on determining the type of technology and nature of the services together, giving them the priority at the strategic and operational levels. This process has its significance in forming the strategies of the firm and in selecting the services and technologies.

In PALTEL, identifying services and technologies are formed from two sides: the first one is from business side who searches for every new services and technologies in the world trying to attract it to be applied in our country; and the second is from technical side who is responsible for

searching for up-to date technology that can operate such new services and technologies.

4.3.1.1 Business Identification process:

Business directorate is one of the major and main directorates that formulate the organizational structure of PALTEL. Business Directorate is structured according to the functional method into different departments; Marketing department; Sales department; Customer-Care department and commercial department. Each one of these department is considered to be a function since it bears specific roles and responsibilities for the business structure.

Marketing is a very important aspect in business since it contributes greatly to the success of the organization; it helps a firm in creating value by better understanding the needs of its customers and providing them with innovative products and services. This value is communicated through a variety of channels as well as through the firm's branding strategy, it is perhaps considered as the most important activity in a business because it has a direct effect on profitability and sales.

Marketing is defined as the process of determining the needs and wants of consumers and being able to deliver products that satisfy those needs and wants.

Marketing includes all of the activities necessary to move a product from the producer to the consumer. It is important to realize that marketing cannot be carried out in isolation from the rest of the business. For example marketing section of a business needs to work closely with operations, research and development, finance and human resources. Figure 4-2 shows the business identification process applied in PALTEL.
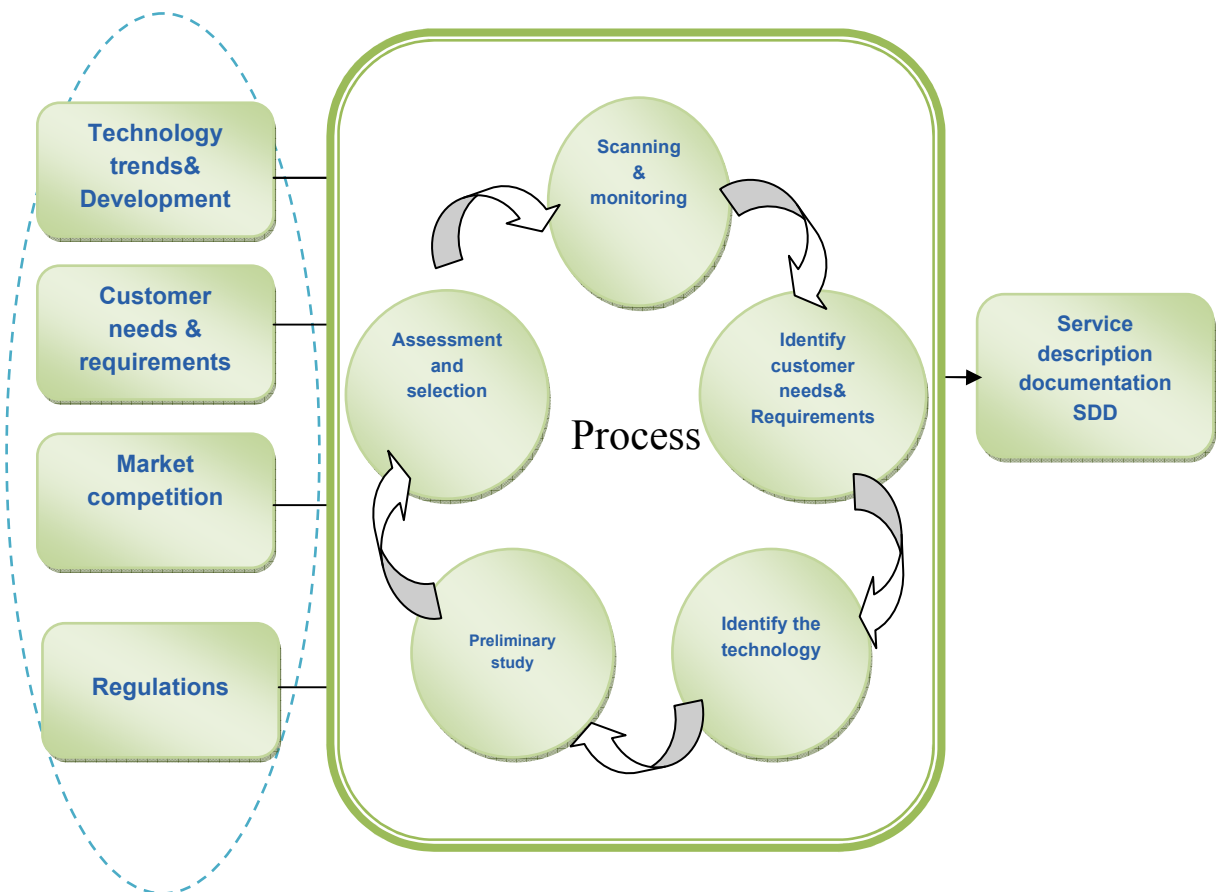

Figure (4-2): Business identification process applied at PALTEL

Business identification process involve three main sub-process which are the input, the main process, and the output.

Input process: contains some external factors that affect the process of identifying the technology and the decision of choosing the appropriate one. These factors are:

1.   Technology trends and developments

2.   Customers needs and requirements

3.   Market competition

4.   Regulation

1.   Technology trends and developments:

Contemporary technology trends especially in telecom sectors are always changing and new developments are constantly improving in data management, data communications, data quality, services application.

PALTEL always keep familiar with and stay abreast with current technology trends and developments, it constantly keep pace with technological development in the telecom sector. PALTEL always committed to attend international exhibitions, seminars and conferences, which shows everything new in the modern communication technology, so the company sending its employees in regular way, to attend such seminars, conferences and exhibitions in order to take advantage of all that is new in this area.

On the other hand, telecom vendors shape one of the primary elements who lead the customers and clients and keep them informed of every changes and developments in the telecom area. PLATEL keep in touch with the vendors to remain informed of everything that is new in the field of modern communications, product and services, and always keep contact with them in order to remain know of the vendor's roadmap regarding the technologies.

Thus keep pace with technological development is one of the most important key inputs to the process of identification and selection of technology

2.   Customer needs and requirement:

Identifying customer needs is an integral element of a company's marketing program. Understanding customer needs helps refine product development projects, marketing communication programs and distribution choices. Correctly identifying customers' needs is essential for ensuring customer satisfaction and loyalty. It is considered as one of the most essential elements of customer retention, customer loyalty, and product repurchase. Companies that launch products without researching and taking account of customer needs run a high risk of failure.

Customer needs and wants are other key input factors that affect the technology identification and selection process in PALTEL. The company always conducts the necessary studies and market surveys in order to

determine the needs of customers for new telecommunications, and Internet services. PALTEL is following up fields of technology used in the world and trying to operate the appropriate technology in the company in order to meet the needs and expectation of the customers and gain their satisfaction. Marketing is about making sure that a business is providing the goods and services that customers want. It involves identifying and anticipating what consumers want today and will want in the future. The marketing department then plays an important role in taking these goods and services to market through all the channels the business sells through.

3. Market competition:

Competitors impinge on the ability of the business to make profits, because competitors constantly seek to gain an advantage over each other, by differentiating their product and service, and by seeking to provide better value for money.

Nowadays in the fast changing environments and technologies developments, most of companies that use technologies keep pace with every changes and development happened in the world. In Palestine, with the existence of many competitors in the business of supplying Internet and telecom services , and with the existence of large organizations and small enterprises and spread of the internet culture in Palestinian society , PALTEL seeks to provide its customer with every new and up to dated services (vpn over fiber, internet over fiber , high internet speed and high

quality of services) in order to keep its customers connecting through it , trying to attract every new customer and maintain the survival of the company at the forefront

Competition in the market always stimulate the company to look for every developments and new services in order to compete the other companies and stay in the foreground

4.   Regulations:

The political and legal system creates the rules and frameworks within which business operates. Ministry of telecommunication is considered as one of the basic and powerful affecting factor in determining the technologies used in the country.

It is responsible for putting and formulating laws, rules and regulations that relates to telecom sector and control the workflow of telecom companies Ministry of telecom set the rules and regulations regarding the following:

➤   Technologies used and services offered to the customers

➤   Frequencies required to operate a particular service

➤   The license required for operating new telecom companies and ISPs

➤   Determining the price of local and International Calls, internet, back holing bandwidth …etc

Identification process: which begins with searching for these new services in the real world by special operation called scanning and monitoring process, passing through identifying customer's needs and requirements, then holding the necessary forecasting studies, analysis, testing and reporting , ending with validation and verification for the success of these services in achieving the target of meeting the customer wants and gaining the predictable profit to the firm , taking into account the external and internal factors that will affect the identification process in the business phase, the tools used, the stake holders involved in.

The identification process mainly includes five processes:

1.   Scanning and monitoring for the new technologies

2.   Identify customers needs and requirements

3.   Identify the technology

4.   Making Preliminary studies

5.   Validation and verification for the new services and technologies

1.   Scanning and monitoring

As the existence of the Internet service providers (ISP) in Palestine increase in the last period and the competition in the internet field become wide spread and strong , PALTEL company keeps tracking for the new services and technologies in the world and become more aware in

providing its customer with new internet services and up-to date technology in the telecommunication and internet sector in order to keep its customer connecting through its network and not to lose them.

Product and services department in marketing directorate always seeks to search for these new services in the market ,therefore they are continuously scanning for the external environment as it is of high importance for the business unit and the company to distinguish the opportunities and threats. Scanning or monitoring the external environment on continuous basis is necessary since the external environment change rapidly and continuously.

Product and services department can do the following

1- Developing new service that will offer new challenges for the customers and Keep them pace with technological development

2- Enhancing and maintaining the current service by adding additional features to it that will allow the customer to use it in the good way

3- Following the Regulatory issue

2. Identify customer needs and requirements:

Over recent years organizations have placed increasingly emphasis on customer services as a mean of gaining competitive advantage. As a competition has become more global and more intense, many organizations have realized that they cannot compete on price alone. Nowadays in the

market places many companies have developed a strategy of providing a superior customer care to differentiate their product and services.

Meeting the needs and wants of customers is the basis of PALTEL company . While the process of meeting those needs and wants may be different for each client, the main goal of the company is to lead the business team in satisfying customer goals and expectations so the company will receive future work.

PALTEL seeks to win customers satisfaction through providing them with the best of its products and services. The market research department in marketing directorate always make continuous research on the market, determining the needs of the markets for the telecomm services, gather information about as many of customers as possible. Knowing the nature of their companies and their need for such services, trying to find out what the customers are buying, why they are buying and the frequency of their purchases.

Marketing research is the function that links the customer, and public to the marketer through information. These information used to identify and define marketing opportunities and problems; generate, refine, and evaluate marketing actions; monitor marketing performance; and improve understanding of marketing as a process. Marketing research specifies the information required to address these issues, designs the method for collecting information, manages and implements the data collection

process, analyzes the results, and communicates the findings and their implications.

Marketing research team in PALTEL works on a regular basis and frequent way preparing researches and studies that examine the market situation and the needs of customers for new services; also marketing team is looking for attracting new customers while maintaining the existing subscribers through regular contact with them to meet their needs and gain their satisfaction. On the other hand they take into consideration the intensity of competition in the market and the impact of competitors.

Finding out what the end customers want, need and expect and how satisfied they are with what they get is very important issue for the success of the firm and it is considered a standard marketing technique . PALTEL use the following methods in determining what the customer needs

I.   Telephone interviews

II.   Questionnaire

III.   Face –to-face interviews

IV.   Focus group: this involve a small group of people from the marketing meeting with the customer to discuss the complicated issue and Introduce new services to them, and if the vip customers like Banks, Governmental and non-governmental organizations

needs   additional services and features to Provides them with what they needs.

3.   Identify the technology:

After identify the customer needs and requirements PALTEL trying to search for every new technologies and services in the world that enable them to serve the customers and provide them with what they want and need to become fulfilled   and happy so PALTEL keep touch with the vendors and large telecom companies to be informed with the last and up-to dated technologies used in the world.

4.   Preliminary study:

Market research is one of the vital components of marketing, it plays its part before one makes any policy decisions in the field of marketing and communications. Market research can be defined as "the implementation of subjective and objective research methods. The main role of market research team is to collect information and analyze it. This information constitutes the basis that enables marketers to (re)define and evaluate their strategies".

The information is generally concerning behaviour, attitudes and motivations of a particular target group. Market research is primarily analyzing consumer behavior in order to discover who is buying, what they are buying, where they are buying it, and when people buy products or

services and then asking the question why are they buying it? And finding out what you can do to entice customers to buy your product or service.

Before introducing any new services and products Market research team in marketing directorate study the market situation and the needs of the customers, formal and informal organizations for the new services. they make the necessary forecasting and predicting studies, analysis studies, and getting the final reports that shows the failure or success of introducing such services in the markets.

In summarized, marketing research team do the following:

➢ Market Analysis

➢ Forecasting studies

➢ Analyzing the collected data

➢ Generating the required reports

➢ Making feasibility studies

➢ Pricing the new products

Output process which includes the results outcome from the identification process and summarized in producing a service description documentation (SDD) that includes a detailed information which describes the requirements of the services, this document usually reviewed and discussed with both technical and business planning managers in order to check the

ability to operate such new services. Service description document mainly describes the services and introduces the list of features that the service will contain.

Service description documentation includes the following main subjects:

➢ Service definition

➢ Service description

➢ Service features

➢ Rational of the service

➢ Target customers

➢ Service development strategy

➢ Technical requirements

➢ Technical specification

➢ Support requirements

➢ Customer service requirement

➢ Billing requirements

➢ Documentation

➢ Training

4.3.1.2 Technical Identification Process

Technical Directorate is the second large directorate in PALTEL, It is divided into two main directorates the first one is Strategic Planning & Development Directorate and the second one is Technical operation directorate. The two directorates are complementary with each other, the strategic planning and development directorate is responsible for developing the future technical plans and strategies that will be applied in the near future which mainly includes plans for operating and running new services, expanding the networks, increasing the number of serving areas, using modern technologies, etc. On the other hand, technical operational directorate works on implementing these plans in order to achieve the stated objectives and desired goals from these plans and strategies.

Technical planning team located on themselves the responsibility of putting the strategic and action plans regarding any new products and services, and taking the decisions that ensure the possibility of providing these new services with best quality and high efficiency. They do following main tasks:

- Putting strategic and action plans regarding running any new product and services
- checking PALTEL network readiness
- Determine the technical requirements needed to run any new product and services.

- Making the necessary studies that clarify The ability of PALTEL network to run any new services by using the current technology, devices and equipments or just making some enhancement and development for the existing one ,or go to the use of modern technology.

Technical identification process is concerned of choosing up-to date, modern and appropriate technology to operate any new services that enable the company to meet the customers' needs and get them satisfied and even offering the best quality services. Technical identification process begins with receiving the Business requests for operating new product and services, the business requirements summarized in a document known as "service description documentation (**SDD**)", which includes in its content a full definition and description of the new service, the specification, characteristics and features of it, in addition to the technical requirements and other parameters needed to operate it. This documents usually reviewed by both technical and business planning focusing groups that studying the possibility of running these new services and applying the required features.

Technical identification process is affected by several factors including (Technological trends and developments, Business requirements, internal technical needs & network assessment, and vendor recommendation). Figure 4-3 shows the general model of technical identification process applied at PALTEL noting that this model is

developed according to interviews I have made with concerned people inside the company
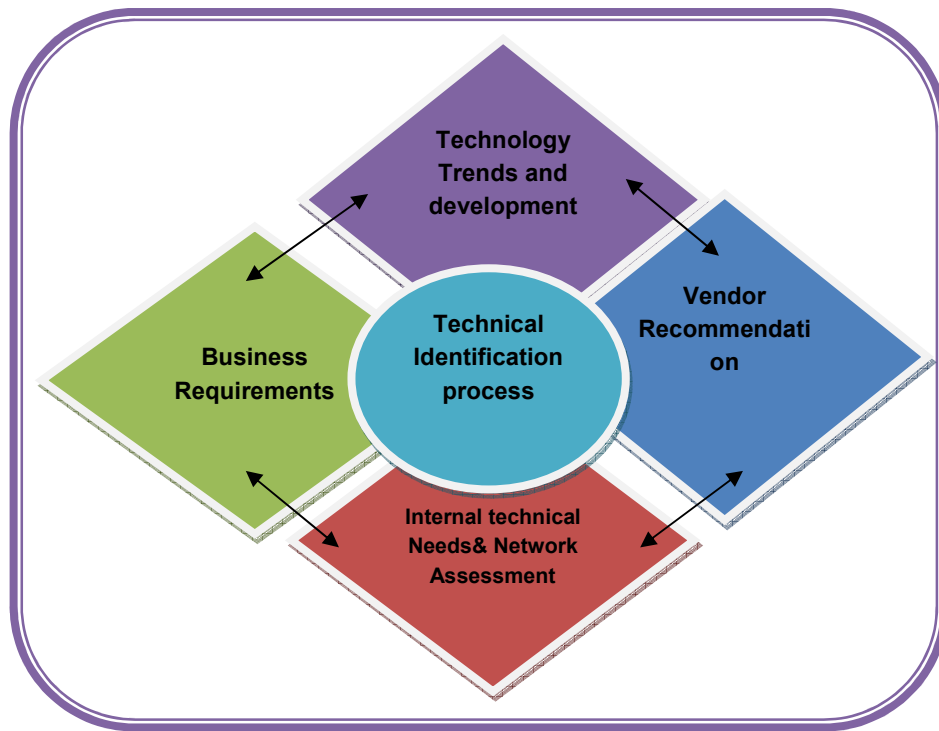

Figure (4-3): Technical identification process applied in PALTEL

4.3.1.2.1 Technology Trends and Developments:

Technological changes and developments have great effects on the process of choosing the appropriate technology in the company. Technical department remains keen to keep up with every technological development in the telecom sector; they always keep in touch with the vendors and suppliers who demonstrate the roadmap of telecom industry and internet world and brief them on the latest developments in the telecom sector and internet services. PALTEL always committed to attend international exhibitions, seminars and conferences, which shows everything new in the

modern communication technology, so the company sends its employees in regular way , to attend such seminars, conferences and exhibitions in order to take advantage of all that is new in this area. On the other hand the company remains looking for every new by searching on the internet and looking to the achievements of other large and international companies in this area.

4.3.1.2.2   Business requirements:

Business requirement presents in achieving all the items that have been documented in the service description documentation "SDD" which mainly consists the features list of the services that they will offer to the customers.

These requirements should be compatible with the technical side as they considered the operator of the new services. Business requirements include the nature and feature of the services, service development strategy, customer service requirement and the ability to enhance and add additional value to it in the future.

4.3.1.2.3 Internal Technical Needs and Network Assessment:

The technical requirements must be fully available in order to operate and provide good products and services to the customers. For this purpose there are four key elements which represent the technical requirements that must be met. Figure 4-4 shows the basic elements of

technical requirements in PALTEL which summarized in: Technology, Tools, Process, and People.

- **T**echnology:

  Technical needs modern and last technology that compatible and match the Business plan to provide what needed of products and services. This technology must be scalable, flexible, and reliable; this will help technical to have a full view and Roadmap toward future and company needs.

- **T**ools:

  Suitable and powerful tools will enhanced and help company to reduce all complicated methods (old versions) to overcome all maintenance issue and also facilitate the speed of solving the problem and faults.

- **P**rocess:

  Powerful and automatic procedures and process help company to decrease all routine procedures and match with new technology and rapid change on life .It help also to speed up providing services and products internal and external in company.

- **P**eople:

  Well trained and qualified employee inside company will improve
  and help it to proceed with new products and service that match with
  Company business plan, in addition to that will decrease the number
  of employee that are working on such services and divide teams to
  specialist division that concentrate on study case or deep
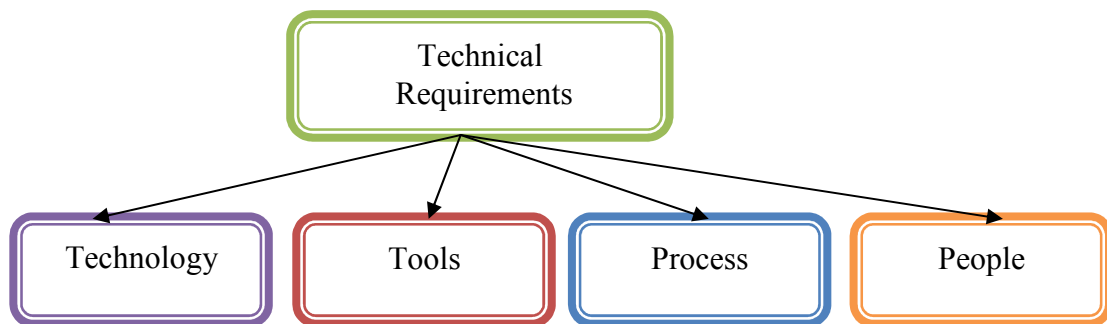 investigation for technical planning or operation tasks.

Figure (4-4): Basic elements of technical requirements in PALTEL

Network Assessment:

Network Assessment gives a clear understanding to whether the
current design, architecture and network performance is meeting business
requirements and needs. It provides a quick snapshot of the current network
with an examination of the infrastructure, performance, availability,
management and security.

To successfully deploy any new services, technical planning mangers
make the necessary assessment for PALTEL network with the assistance of
experts and consultants who studies and analyze the network of PALTEL

and put their recommendation regarding running the new service. The experts and consultants usually identify the extent of the network's ability to provide the new services and identify the needs and requirement to supply these services, also determine whether there is a need to use new technology, install new devices and equipments or simply to make some improvements and enhancement to the existing one.

Technical team usually working on checking the technical requirements necessary to supply new services and working on:

1. Finding out the technical requirements ,specification, criteria needed to run the new services

2. Verifying the ability of the current used technology, network, devices and equipments, to support new services or they needs to make some improvements and enhancement or use new one.

3. Assess the readiness of the network from all perspective and sides, network assessment include assessment of the following elements:

    - Network design

    - Configuration

    - Accessibility

    - Management and security

    - Devices and equipments

    - Location availability

- Network layer i.e. (IP-core side, switches ,Transmission side, access side, , etc….)

I will briefly explain some of these elements

- Network design

  Planning team in collaboration with experts and consultants review PALTEL network design and the distribution of the core devices and equipments in the whole network and areas which includes the following devices :

  ip-core devices: BRAS's, routers, switches, access devices: ISAM,IP DSLAM, ATM, Transmission devices: SDH, metro Ethernet devices

- Configuration:

  Planning team always review the configuration of PALTEL network and the way they connect the core devices (ip devices ,access devices, transmission devices) with each other, on the other hand they make continuous improvement and upgrade to the hardware and software if needed.

- Management and security

  The development of a security policy and strategy is important to protecting company assets. The company security strategy is considered and problems identified that would affect company operations. Network management and security is one of the most critical elements that must be evaluated and considered during the

evaluation and assessment of the network. Planning team check all the means, elements, tools and software that enable them to manage, control and follow-up PALTEL network any time, also check the security systems that provide the necessary protection for the whole network and core devices in the network when something goes wrong and protect it from external attack or intrusion

- Devices and equipments

According to the continuing evolution in the telecommunications sector and the revolution caused by the Internet in the world, PALTEL telecom service provider keen to keep up with this revolution and follow all that is new in this area ,so it is working hard to develop its network by installing latest equipment and devices that provide the best quality services and serve the largest number of participants. Planning technical team assesses the ability of the current installed devices to provide the new services and its ability to serve the growing numbers of internet subscribers in west bank and Gaza strip.

Network assessment provides a complete picture of the network status and potential with an examination of the infrastructure, performance, availability, management and security.

4.3.1.2.4 Vendors recommendations:

Vendors are also considered as major players in the process of identifying and selecting the appropriate technology to the firm, they shape an important factors that affect the decision of choosing the appropriate telecommunication systems, that because of the telecommunications system is a long-term investment for the company and the success of telecommunications services is directly affected by the vendor selection decision. PALTEL always keep communicate with suppliers to see the roadmap, technology evolution and destination that moving forth suppliers in providing the latest technology related to the communication field in order to be abreast of every development. PALTEL usually make differentiation and comparisons between vendors by looking to the criteria and specifications of the services and devices they provide. They usually make request for proposal **(RFP)** that differentiate between the vendors with accordance to several criteria. **RFP** includes an overview of the projects that will be applied at the company, the statement of the work, the scope, specifications and requirements of the work, vendor information, vendor qualifications, vendor certification, evaluation criteria, technical and financial evaluation criteria, budget& estimated pricing, selection and notification. They usually looking for basic technical criteria that enable them to provide high quality of services and enable them to add additional value to it in the future, in addition to considering the operational and financial criteria.

4.3.2   Technology Selection and Assessment Process:

Technology selection process is a mature process that simplifies the effort required to make the appropriate technology choices for the organization. Consultants, experts and providers are considered to be the main and most important agencies that help the company in taking the right decision regarding the choice of technology.

There are different ways that are normally followed by PALTEL to facilitate the decision making for the selection of a technology:

- Request For Information

- Request For Proposal

- Request for Quotation

- Workshops

- Seminars

- Exhibitions

- Local & International Forums.

The above ways help PALTEL becoming aware of what could be the best technology to adopt and select, they also help in speeding up and accelerating the decision making process.

Now, before selecting a technology and taking a final decision, a professional committee is formed. Committee team members from technical, procurement, financial and commercial departments are normally involved in the selection process.

A primary report is prepared where a comparison is being made between the different proposals or quotations. This comparison involves the cost of technology or solution, the warranty period, the cost of maintenance, and the upgrades and the technical and operational specifications. This primary report strongly helps in identifying those companies or solutions that look suitable and feasible to PALTEL.

The project management office or the steering committee and the high level management must always be aware of what's happening and how the selection process is moving because there could be other management considerations and perspectives that need to be taken into account.

The technology to be selected must be compliant with existing systems inside the company. It must also have the ability and flexibility to be integrated with other needed systems existing in the company.

Every specification and technical issue of each of the elements of the new technology is weighted and assigned a weight based on importance with regards to the technology. Financial and procurement team members

also make legal and financial analysis study to determine if technology worth and feasible to invest in or not.

The evaluation starts by giving marks/figures to each item with reference to its weight, and finally the decision is made to select the best technology that suits the current situation of the company and that covers the maximum technical requirements and needs of the company. In many of the cases the committee team members use their skills in the evaluation process.

Here are some of the Technical, Financial and Operational criteria that can be assigned and weighted.

Technical Criteria

- Technical features/characteristics

- System reliability/availability

- System performance

- System capacity

- Upgradability on H/W and S/W

- System redundancy

- Future technology development

- Compliance with international standards

- Interoperability with other systems

Cost factors

- Capital investment

- Unit cost

- Operating cost

- Maintenance cost

- Cost of network management system

Operational factors

- Fault diagnosis capabilities

- System security features

- Ease of operations

- Performance monitoring capabilities

- Billing flexibility

Testing New Technology:

In order to ensure that the new services PALTEL provides do meet the desired goals, specifications, requirements and fit the whole design and ensuring that the services operate in an efficient and effective way, PALTEL usually makes continuous examination and reviews the services it

provides before and after they are installed and activated on ground prior to launching the service in the real life.

The technical planning team defines a new line as **a customer test line** and defines the service and its features to initiate the test and verifying the following parameters:

- The operation and running of the service,

- Service quality

- Service stability and Continuity

- Check if the service meets the business requirements as describes in SDD

- Service reliability, flexibility, security ,redundancy and manageable

- Verifying the compatibility of the new service with the running network plat forms

The above parameters are considered to be very important in verifying the operating of the service in a good way, testing the success of the service, measuring its performance, Effectiveness, efficiency and ensuring operating it in the best way, with best quality, continuity, and no Jamming.

Chapter Five

Technology Identification and Selection Model

Technology management is a challenging topic, in terms of both theory and practice, the implementation of effective technology management requires a number of elements to be in place. Firstly, practical tools are needed for supporting management decisions and action, together with techniques for their application. Secondly, management processes are required for combining tools and techniques to address specific business problems. Finally, conceptual frameworks are needed to guide thinking about technology management, based on well-founded theoretical principles.

A large number of models and theories have been developed to adopt technology management framework. Phaal (2004) developed a framework to support the understanding of technological management in relation to other business processes. The framework combined two sets of business processes necessary for effective technology management were examined, the first set comprised of core business processes of strategy, innovation and operations; the second set considered another five supporting technology management processes. Integration between these sets was supported through knowledge flows that should occur between commercial and technological functions; see Figure (2-3) Section (2.2.4).

Based on reviews of technology management practice and findings of this research, the researcher devised a conceptual model for technology management activities (identification and selection to be deployed in one of Palestinian telecom firm; PALTEL .

5.1   Technology Identification model:

Technology identification is the initial sub-process of the technology management process; it comprises systematic scanning of all technologies that are or maybe of significance to the business. Companies should monitor technology emergence in order to reduce their susceptibility to technology change. However, this process should not be performed in an ad-hoc manner; companies need to establish technology activities within the firm so technology identification can be performed in a systemic way.

This section will describe the identification model and explain the key components of this model ; also discuss how it can be used in the PALTEL firm. As shown in Figure (5-1) below the model consists of five main processes: Technology trend & road mapping, Technology scanning and monitoring, Competitive analysis, Market analysis and Network analysis.
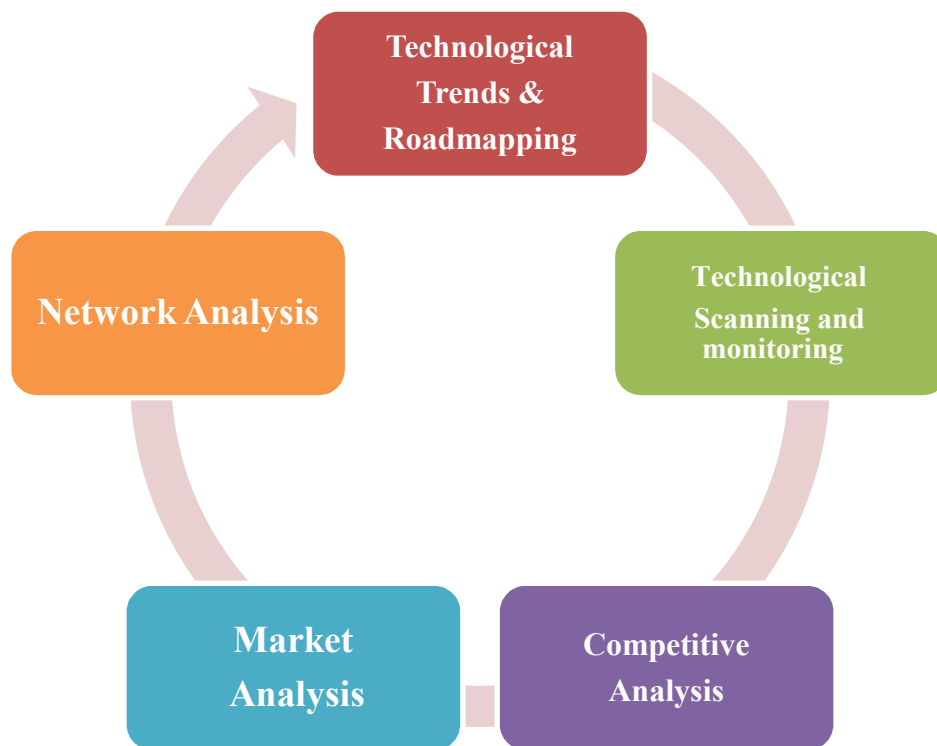
Figure (5-1): Technology identification model

5.1.1 Technology Trends & Roadmapping:

Among the main and very important technology management activities , comes technology roadmapping which is crucially important to the Palestinian firms in order to set their competitive priorities and develop plans that help them further their missions.

Technology road mapping is a useful technology planning tool in an increasingly competitive environment; it is one of the most widely used methods for supporting the strategic management of technology. It represents a powerful process for supporting firm-based strategic management ; it provides a framework for linking business directly to

technology, thus it has been widely used within industry , organizations and individual firms. (Barker and Smith, 1995; Bray and Garcia, 1997).

The success of road mapping as a managerial tool has spawned the creation and acceptance of other techniques that are similar to road mapping, such as technology foresight, technology forecasting, and data scanning.

companies need to think seriously about what their business really need and how they are planning to meet these needs. Technology roadmapping will help the company to predict change and avert any risk caused by incorrect technology investment decisions; it is the process that will help companies achieve their strategic purposes and keeps the money invested in technology; though companies need to perform technology planning and adopt a structured approach to it;

Companies should have a clear roadmap that helps them at the business level to forecast technological future trends, identify the trends that will have the greatest impact on future business.

On the other hand, companies are required to be familiar with and stay abreast of current technology trends as contemporary technology trends are always changing and new developments are constantly improving in data management, and quality. Obtaining a broad view of emerging trends and new technologies as they relate to business can help an organization anticipate and prepare for the future.

Organizations that can most effectively grasp the deep currents of technological evolution can use their knowledge to protect themselves against sudden and disruptive technologies. Therefore, companies need to identify the competing and disruptive technology that will affect its business. Disruptive technologies often disrupt workforce participation by allowing technologically unsophisticated individuals to enter and become competitive in the industrial workforce. Disruptive technologies can evolve from the confluence of seemingly diverse technologies or can be a result of an entirely new technological investigation. Disruptive technologies can be either a new combination of existing technologies or new technologies whose application to problem areas or new commercialization challenges (e.g., systems or operations) can cause major technology product paradigm shifts or create entirely new ones. Disruptive technologies create growth in the industries they penetrate or create entirely new industries through the introduction of products and services that are dramatically cheaper, better, and more convenient.

According to (Garcia, Marie L., 1997), the development of technology roadmap consists of seven main steps.

1. Identify the "product" that will be the focus of the roadmap.

2. Identify the critical system requirements and their targets.

3. Specify the major technology areas.

4.   Specify the technology drivers and their objectives.

5.   Identify technology alternatives and their time lines.

6.   suggest the technology alternatives that should be pursued.

7.   Create the technology roadmap report

5.1.2 Technology scanning and monitoring

Prediction the impact, scope, and direction of technological changes are one of the major difficulty and challenges faced when managing technology and innovation. Technology scanning and monitoring is a series of ongoing studies that tracks trends, technologies, and innovations.

Technology monitoring has a major position in business field since the monitoring and forecasting of the development of technologies and staying abreast of changes in technologies is crucial for strategy setting and policy making. As mentioned earlier in section 2.3.2, monitoring is, "to watch, observe, check, and keep up with developments, usually in a well-defined area of interest for a very specific purpose." It is a continuous surveillance on emerging technologies. This typically requires domain experts' time and effort on gathering, organizing, and analyzing data.

Figure (5-2) demonstrates the primary sub challenges that a company needs to tackle in order to structure a way monitor of external technologies. It is necessary that the company firstly defines and states clearly what

technology and technological sub-systems should actually be monitored, and then explain how a technology should be assessed; concentrating on how application areas could be stated and how the information need must be defined. Next is to define how to monitor and analyze the technology. The final and most crucial step is to communicate the relevant information to decision makers.
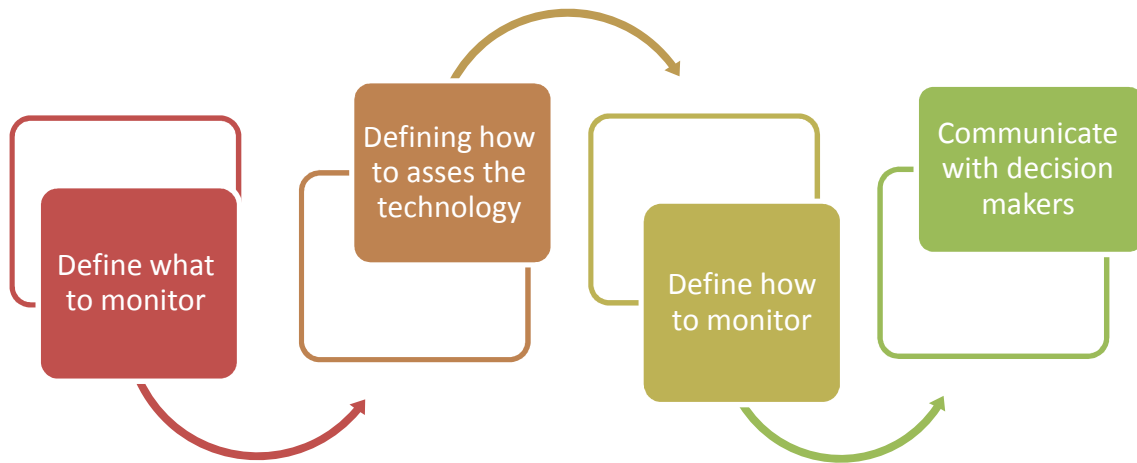
Figure (5-2): Technology monitoring framework

5.1.2.1 Define what to monitor

A core component of technology monitoring is to define and state clearly what is technology and technological development. We must define clearly all technologies that will be recorded and monitored. If a technology is not properly defined, it is difficult to conduct any relevant analysis. Such a definition offers us a rich comprehension and summary of the technology context and gets us a good understanding and overview of

what the technology context looks like. This defining process encourages us to become acquainted with all relevant functions and components.

5.1.2.2   Define How to Assess a Technology:

The preliminary appraisal of a new technology is crucial for the success of the technology monitoring process. Through the definition process and by identifying how the technology should be assessed many important points would be clarified such as who the decision makers are, what information they need, and the ideal method for them to receive this information.

The Assessment of technology and the strategy for monitoring of external technologies are quite relevant to the appraisal of technology. Hence, it is crucial for the firm before beginning to monitor the external technology to have a strategy outlining why and how each surveillance activity has a relation to broader technology and product strategy, how the technology development should be monitored and how best to utilize the monitored technology. This process is split into two major activities, defining the application area and defining clearly the information necessary

- ***Defining the Application Area for the Technology:***

The fundamental part of the initial assessment is to define what are the potential application areas for a new technology. That is because the application area determines what competing technologies and sub technologies that need to be monitored since they often depend on in what context the technology is going to be used. The assessment of application areas should take place in a cross functional workshop setting, where people with different background and competences work together, converse and discuss plausible application areas for a new identified technology The aim of the workshop is to create, critique and evaluate ideas for applications, and to decide what application areas are worthy of further study or consideration. Therefore, it is essential to make an appraisal of the potential application areas, so as to search for the accurate information.

The appraisal of the potential application area can be done in several ways, Techno-Economic Analysis (TEA) is considered as one of the primary approach to assess the application areas for a technology (Lindmark, 2006). The main aim of the TEA is to conceive , investigate and analyze the relationship and interactions between technical and economic variables of an invention, through linking the technologies with their functions, efficiency and application areas, and at the end its utilities within the application areas and the potential market segments related to that.

The primary elements that should be taken into consideration when constructing the TEA are demonstrated in Table (6).

Table (6): Key analytical parameters for the TEA (Lindmark, 2006).

Analytical parameters	Explanation
Technology	The technology or set of technologies that is being assessed
Functions	What purpose the technology have in the different technical systems where it could be included, describing what it could do
Technical performance and cost	A quantifiable and measurable dimension of how well the function is delivered
Applications	Group of different users systems which might differ depending on the technical characteristics
Utilities	Define the utilities that the customer might perceive
Market segments	Group of users which might differ depending of the different utilities perceived

- ***Defining the Information Needed and Technology Criteria***

The next step after plausible application areas have been appraised is to focus on and look at what information that will be needed about the technology, what data needs to be collected, what specifications must be met and what criteria the technology needs to meet, so that the technology is rendered of interest to the business. The appraisal of information need and technology criteria involves two different parts. First, it is important to decide on what information will be needed in order to be able to assess the technology. Second, it is crucial to decide in relation to what the technology should be assessed. One concept that is strongly ties these two assessments together is the use of technology characteristics to define a technology. Technology characteristics aid the business to define where on

the S-curve the technology has arrived and how relevant the technology would be for use in the business, so that investments could be done in the right time and in the right technologies according to the strategy.

It is significant issue to give more attention, lay out the monitoring resources, and concentrate on the data gathering to the technologies that are considered most useful to the firm and have essential influence on the business of the company.

5.1.2.3   Define how to monitor: Using Indicators for Monitoring and Analysis of the Technology:

According to (Chang, 2008) "Technology indicators could be defined as attribute or values that can characterize and evaluate technologies". Technology indicator can be used as a tool to monitor systematically the developments of technology in a given area and it could be used for monitoring external technologies. Technology indicators could also be used to monitor and measure the insinuation of competitors.

Checking and investigating the information circulated and published about technologies, technological developments and trends are considered one of the major challenges in technology monitoring activities. Therefore there is a need for a regular and systematic procedure for getting key information about the technology characteristics, such as efficiency, performances and developments. This could be achieved by identifying technology indicators, which are considered as one effective way for assessing and monitoring a technology.

The general type of technology indicators are market development indicators and technology development indicators. The technology development indicators are supposed to help determine how far along the development pathway the technology has advanced, and the market development indicators are supposed to help determine the potential commercial payoffs of the technology. Figure 5-3 shows the technology indicator proposed by (chang, 2008)
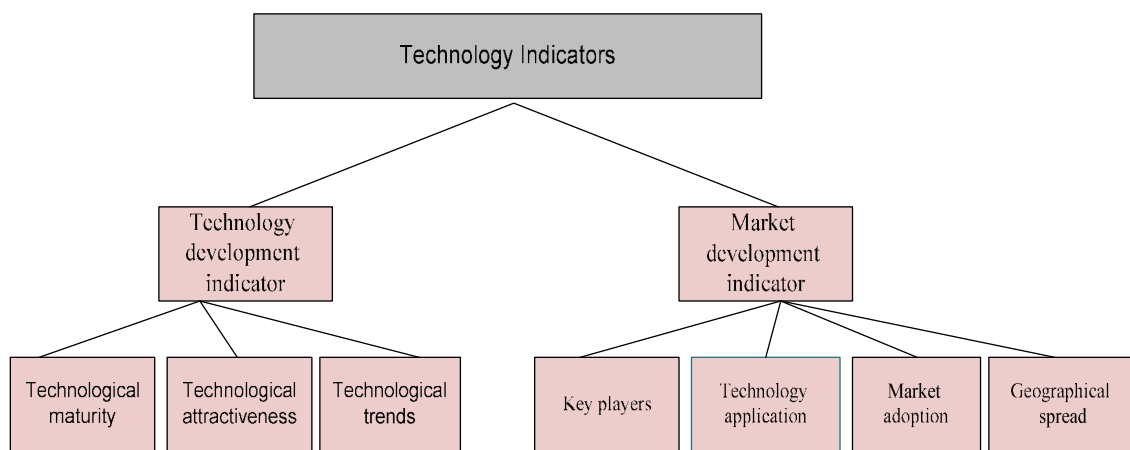
Figure (5-3): Technology indicator proposed (chang, 2008)

5.1.2.4 Communicate with decision makers

One of the most important stakeholders to the technology monitoring process are the decision makers from senior management such as technology managers or business managers who make the important strategic decisions, e.g. on the R&D budget or on mergers and acquisition. However, these stakeholders are also the most challenging to satisfy.

5.1.3 Competitive Analysis:

Competitive analysis is a vital need in business plans and it comprises a fundamental part of corporate strategy as it highlights the business's position competitively in the market space and aids the business to create competitive strategies. So, it is thought to be a fundamental component of the firm's marketing plan. With this analysis, firms can establish what makes its products or services unique and therefore what attributes the company play up in order to attract the target market. Competitive analysis can be defined by "the process by which a company attempts to define and understand its industry, identify its competitors, and determines the strengths and weaknesses of its rivals and anticipates their moves" Zahra and chaples (1993).

In formulating a strategy, managers need to reflect on their competitor's strategies. A competitor analysis has two primary activities:

1.   Getting data about relevant competitors

2.   Using that information to forecast and predict competitor behavior

Firms need to reflect on how their business will compete and they must single out and identify bases of competition and appraise their major competitive advantages and primary technical abilities. Thus, in creating a business strategy, managers need to think about their competitor's strategies, and the strategists need to think about external factors, including

the competitive environment as well as internal factors whilst formulating the strategy.

To begin a competitive analysis, company needs to answer these key questions:

- Who are, and who have been, the firm's competitors

- What threats do they pose?

- What is the profile of the competitors?

- What are the aims of the competitors?

- What strategies are the competitors following and how successful are these strategies?

- What are the strengths and weaknesses of the competitors?

Competitor analysis has several important roles in strategic planning

- It aids the management to comprehend their competitive advantages/ disadvantages relative to competitors

- It helps to understand the competitors' past, present and most importantly future strategies.

- It provides an informed basis to formulate strategies to attain future competitive advantage.

➕ It aids and helps predicting the returns that may be earned from future investments (e.g. how will competitors react to a new product or pricing strategy?

A major aim of competitor identification is to augment and increase the awareness of managers to competitive opportunities and threats. The first step in conducting a competitor analysis is to identify the firm's competitors. Once can start this process by taking into consideration the range of competition existing in the marketplace as competition varies and the firm will be confronted with various forms of competitors (Direct competitors, Indirect competitors, Future competitors)

The five forces model of Porter (1998) is an outside-in business unit strategy tool that is used to form an analysis of the attractiveness (value) of an industry structure. The competitive forces analysis is made by the identification of five fundamental competitive forces; this is showed in Figure 5-4 Porters five forces of competition.

Threat of new Entrants

Power of Suppliers

Competitive rivalry

Power of buyers

Threat of new Substitute products
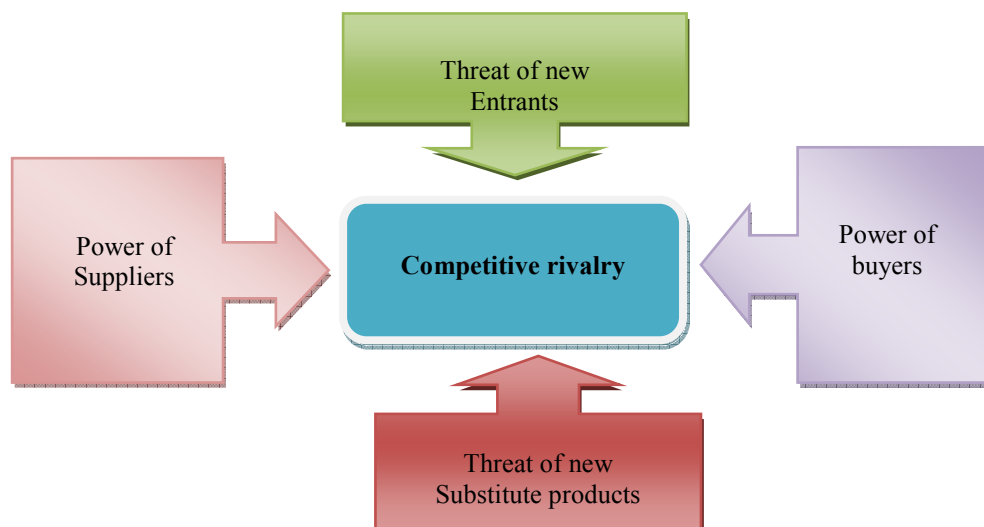
Figure (5-4): Porter's (1998) five forces of competition

- Threat of new entrants: How easy or difficult is it for new entrants to start competing?

- Threat of new substitute products: How easy can a product or service be substituted, especially made cheaper?

- Bargaining power of buyers: How strong is the position of buyers? Can they work together in ordering large volumes?

- Bargaining power of suppliers: How strong is the position of sellers? Do many potential suppliers exist or only few potential suppliers, monopoly?

- Rivalry among the existing players: Is there a strong competition between existing players? Is one player very dominant or are all equal in strength and size (Porter, 1998).

By performing SWOT analysis or any other beneficial competitive analysis techniques, the company can evaluate the competition by determining the strengths and weaknesses of the competitors within their market, strategies that will provide them with a distinctive advantage, the barriers that can be developed so as to stop competition from entering their market, and any weaknesses that should be improved within their products.

5.1.4 Market analysis:

Market Analysis is an important and crucial part of any good business plan. It is also a major and critical part of marketing decision

making and is considered as the core of the business plan for the following reasons:

- It singles out and identifies every relevant aspect of the market in which and to which the company will market its product or service.

- It helps in bettering and improving management decision making by providing relevant, accurate and timely information.

- It is also a very important component in developing the business plan and key to get advantage over competitors.

- It is a continuous process for gathering data on product characteristics, suppliers' capabilities and the business practices that surround them plus the analysis of that data to make acquisition decisions.

Before describing the marketing and sales strategies, company need to Figure out and understand what market they will cater to and should be served and what needs to fulfill. A market is defined as a place where we can sell goods to a specific category of buyers. Hence it is the "where" your good or service is sold and the "who" you sell it to.

A widely quoted definition of marketing was proposed by the American Marketing Association (AMA) in 1985 that "marketing is the process of planning and executing the conception, pricing, promotion and distribution ideas, goods and services to create exchanges that satisfy individual and organizational objectives" the definition was adapted further

in 2004 by stating that "marketing is an organizational function and asset of processes for creating, communicating and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stakeholders"..

Market analysis can single out market trends, demographics, economic shifts, customer's buying habits, and important information on competition. It is imperative for a company to know what type of goods or services would be profitable to introduce in the market. Also in relation to its existing products in the market, comprehensive and good market analysis enables a company to know if it has manage to satisfy customer needs and whether any changes need to be made in the packaging, delivery or the product itself.

As mentioned earlier market analysis can be used to develop business and marketing plans or to measure the success of a current plan however, for this research to be effective successful companies need to conduct research on continual basis to keep up with market trends and to maintain a competitive edge. Market Analysis of the business plan should include the following key elements:

5.1.4.1 Market Size:

Companies need to be aware of the market size. Market size is understood through the market potential and the market volume, Market size can be identified on the basis of data obtained from trade associations,

customer surveys and market information from the primary businesses and government data

In order to determine market size a business also needs to identify the target customer. "Knowledge of the customer enables you to determine the market size and what determines their buying decision.

There are various methods that can be used to determine market size. One typical approach is to use the following formula:

"Market size = number of buyers in the market x quantity purchased by an average buyer in the market per year x price of an average unit ".

Another way for determining market size includes the use of external information sources. Examples of outside information sources include government data, financial data from industry experts, trade associations, and customer surveys.

5.1.4.2 Market Trends:

Changes in the market have an important role because they often are the source of new opportunities and threats. Market trends refer to the general fluctuations and movements of an investment market. Market trends give businesses opportunities to reap a large and huge profit on these trends by creating products that fulfill new desires. Market trends involve customers, competitors, and the industry as a whole. The firms need to determine what is important to its current and target customers, what

customer needs are not currently being satisfied, what current strategies the competition is changing, and what new strategies the competition is implementing.

5.1.4.3 Market Growth Rate:

Companies need to forecast and predict to what extent a market will develop and grow. This can be achieved by looking at the current market growth rate and estimating the future growth rate on the basis of this. Identifying the market growth rate helps companies determine and facilitates firms understanding whether the size of the market is likely to increase at a level in which the company is able to compete. A favored method of determining the market growth rate involves the study of "growth drivers such as demographic information and sales growth in complementary products

5.1.4.4 Market Demand:

Market demand is one of the most important and useful methods for companies to determine what to sell and if so how to deliver the goods and products they produce to the market. Market demand is defined as the total amount of purchases of a product or family of products within a specified demographic. Market demand is defined as the total amount of purchases of a product or family of products within a specified demographic .It is also defined as the total demand of every individual willing and able to buy a

good. When establishing a business in a new market, companies must perform an analysis of the demands of a particular product or service.

5.1.4.5 Market Profitability:

Market profitability relates to the amount of profit a business can generate within a specific market. It also refers to the "minimal market area an activity must have to stay in operation". To understand how to generate profit in a market, the average profit potential for a market can be used as a guideline for knowing how difficult it is to make money in the market. Determining the market profitability helps a company determine whether they can earn a profit selling a particular product in a particular market.

Michael Porter developed a framework called Porter's five forces, which pinpoints five things that affect market profitability: "buyer power; supplier power; barriers to entry; threat of substitute products; rivalry among firms in the industry.

5.1.4.6 Customer needs and requirements:

Anticipating a customer's needs is an important part of most retail and wholesale businesses, especially in a more challenging retail environment. Anticipating needs also provides opportunities for personal and professional growth.

Customers are people who buy products and services from other people or companies. What customers think and feel about a company and

its products is a key aspect of business success. Marketing is about making sure that a business is providing the goods and services that customers want. It involves identifying and anticipating what consumers want today and will want in the future. The marketing department then plays an important role in taking these goods and services to market through all the channels the business sells through. It Involve understanding who the customers are and what they want

5.1.5 Network Analysis:

Network analysis provides a complete picture of the network status and potential with an examination of the infrastructure, performance, availability, management and security. Technical people should analyze network readiness and its ability to run and operate the new services, they should have to finding out the technical requirements, specifications, criteria and assess the readiness of the network from all perspective and sides (Network design, Configuration ,Accessibility, management and security, Devices and equipments, Location availability, Network layer i.e. (IP-core side, switches ,Transmission side, access side,).

To successfully deploy any new services, managers need to make the necessary assessment for PALTEL network with the assistance of experts and consultants who study and analyze the network of PALTEL and put their recommendation regarding running the new service and determine whether there is a need to use new technology, install new devices and equipments or simply to make some improvements and enhancement to the existing one.

5.2   Selection Model

Technology Selection is the second sub-process of the technology management process; it involves defining requirements and prioritizing alternative technologies. Companies need to select technologies that are aligned with their business and financial objectives and capable to support and promote the business.

Based on reviews of technology management practice and findings of this research, the researcher devised a conceptual model for technology selection to be deployed in one of Palestinian telecom firm; PALTEL.

As shown in figure (5-5) below the selection model consists of five main processes: Technology investment analysis; Technology assessment; Technology trends; Suppliers and Selection technique.
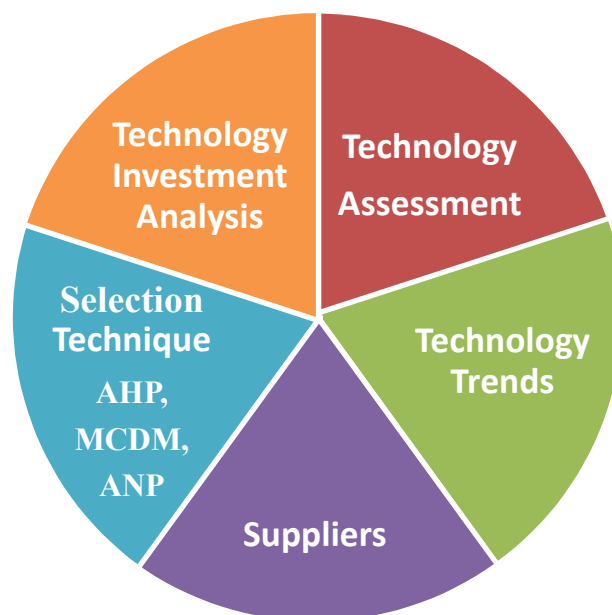
Figure (5-5): Technology selection model

5.2.1 Technology Investment Analysis:

Companies should make a comprehensive investigation of the financial and technical capabilities for the new product or technology that will acquire, identifying the extent of the importance of this technology in return of investment and what returns can be expected from investing in such technology

In addition to specifying the criterion and processes that will be used to select this particular technology .Therefore, if the technical and financial departments come to an agreement that the new technology is technically and economically feasible; companies then need to have the answer for the following questions

1.   Why is the technology being implemented?

2.   What are the requirements to implement the technology?

3.   What are the alternatives considered?

4.   What are the criterion and processes that will be used to select this particular technology?

5.   What returns can be expected from investing in such technology?

6.   What are the expected financial benefits of the new technology, measured according to established financial metrics, including ROI, savings, and payback period?

7. What are the technology's specific business benefits, such as operational savings, increased availability, increased revenue, or achievement of specific goals?

8. How will the new technology make improvement to the business, such as simplifying management, reducing support costs, boosting security, or increasing productivity?

9. What are the potential risks associated with the new technology ?

10. What are the cost implications of implementing the particular technology?

11. What is the vendor's capacity to provide technical support?

12. What quantitative benefits do we expect to realize from applying this technology?

13. What investments need to be made to make right selection of technology?

14. How will the company know when the new technology is success? How will the success be measured (metrics and time frames)?

By answering these questions the company will have a clear perspective on how to invest in technology and consequences of each decision can be clearly identified.

5.2.2 Technology Assessment:

Technology assessment is a family of principles, values, approaches techniques and tools for adequately assessing the potential value of a technology and its contribution to company's competitiveness and profitability. An exhaustive assessment evaluates the technology and its associated value from technical, market and consumer perspectives and reconciles these findings within a valid methodology.

Technology assessment is a helpful tool in the decision-making process, it is considered as a powerful technique for an organization in examine new ideas, identifying and analyze causes or potential change, develop and plan possible solutions and finally select and implement the proposal technology.

The evaluation of a proposed technology must be very careful, considering and identifying all the factors that will affect the whole organization. These main factors are expected financial benefits, competitiveness, added value in its products and the impact upon the business as a whole.

According to ITA (1998), the typical components in a technology assessment include:

1. problem definition

2. description of the technology

3.   prediction of future technology development

4.   identification, analysis and evaluation of consequences

5.   communication of the results in a generally accessible form

Technology assessment has many benefits to the company:

i.   It provides a methodology and a set of structured actions, which enables the enterprises to take into mind all the factors related with the proposed new technology.

ii.   By implementing the technology evaluation technique the organization will be able to identify improvement opportunities, innovation perspectives in products, processes and services.

iii.   Technology assessment is one of the most significant techniques in innovation function, such as technology transfer and it is best utilized in screening new ideas, assessing innovative or not innovative technologies.

iv.   when a structured methodology is followed it will cost and last less more than working randomly without any plan, so recourses can be preserved for other activities of the enterprise.

Companies should make assessment for the chosen technology and services to ensure that it meets the desired goals, specification, and requirements. By making technology assessment the company will have a clear perspective on how to invest in technology and consequences of each decision can be clearly identified.

5.2.3 Technology Trends:

The technological trend characteristic is useful to decide what the technological development is focusing on. Following trends in technology can help technology-oriented businesses spot future product demand. Technological changes and developments are considered one of the main and core inputs that will affect the decision of using the technology in the company; therefore companies should remain keen to keep up with every technological development in the telecom sector; and keep in touch with the vendors and suppliers who demonstrate the road map of telecom industry and internet world and brief them on the latest developments in the telecom sector and internet services.

5.2.4 Suppliers:

In today's global market, competition between firms is fierce, and customers are constantly demanding technically more advanced products. In order to meet these demands, firms are increasingly relying on suppliers to gain access to leading technology and to get their help in developing products with high performance. Strong competitive pressure forces many

organizations to provide their products and services to customers faster, cheaper and better than the competitors. Managers have come to realize that they cannot do it alone without vendors and suppliers. Therefore, the increasing importance of supplier selection decisions is forcing organizations to rethink their purchasing and evaluation strategies.

5.2.5 AHP model:

One needs to have a way of viewing the problem in an organized structure and framework when dealing with multiple conflicting criteria and various types of data in the decision making process regarding telecommunication technology. The structure needs to facilitate the interaction and interdependence among all factors that have an effect on the choice of technologies, and enable one to think about them in a simple way. AHP and other multi-criteria decision analysis techniques provides a straight-forward and logical framework that enables an individual or a group of stakeholders to make effective decisions in such situations by providing a structure in the decision making process.

Analytic Hierarchy Process (AHP) is originally introduced by Saaty (1980) as an effective multi criteria decision making tool (MCDM) which was acknowledged by many researchers. The AHP is a method of breaking down a complex, disorderly, unstructured situation into its component elements; ordering these elements into a hierarchic order; assigning numerical values to subjective judgments based on the relative importance

and significance of each element; and synthesizing the judgments to determine the priority of elements.

One of the main advantages of Saaty's AHP is its simplicity in relation to previous decision support methods. By giving a basis for eliciting, discussing, recording, and evaluating the elements of a decision, it also enables qualitative and quantitative into the same decision making methodology. It uses hierarchal way with goals, sub goals or factors and alternatives.

The input to AHP models is the decision maker's answers to a series of questions of the general form, 'How important is criterion A relative to criterion B?' These are termed pair wise comparisons.

The AHP modeling process involves four phases:

1.   Structuring the decision problem and selection criteria

2.   Measurement and data collection

3.   Determination of normalized weights and

4.   Synthesis-finding solution to the problem.

1.   Structuring the decision problem and selection criteria

This phase involves formulating an appropriate hierarchy of the AHP model consisting of the goal, strategic factors, criteria and sub criteria and the alternatives. The goal of our problem is to select the appropriate

telecommunications system that can meet customer requirements, bring profits to the firm, and compete strongly in the telecommunications market. This goal is placed on the first level of the hierarchy as shown in Fig 5-6. Two strategic factors, namely cost and quality, are identified to achieve this goal, which form the second level of the hierarchy. The cost factor is important because the lower the cost of a service, the higher the productivity and efficiency, thus bringing more profit to the company. Quality is equally important as it focuses more on meeting customers' requirements and becoming competitive in order to stay ahead in the marketplace. The third level of the hierarchy occupies the criteria defining the two strategic factors of cost and quality of the second level. There are two criteria related to cost, namely capital and operating expenditures. On the other hand, the criteria associated with quality are technical, operational and vendor. The fourth level consists of the 26 sub criteria, which is grouped with respect to the five criteria occupying the third level, as shown in Fig 5-6.

The strategic factors, criteria and sub criteria used in these three levels of the AHP hierarchy can be assessed using the basic AHP approach of pair wise comparisons of elements in each level with respect to every parent element located in one level. A set of global priority weights can then be determined for each of the sub criteria by multiplying local weights of the sub criteria with weights of all the parent nodes above it.

Figure (5-6): Analytical Hierarchy Process AHP
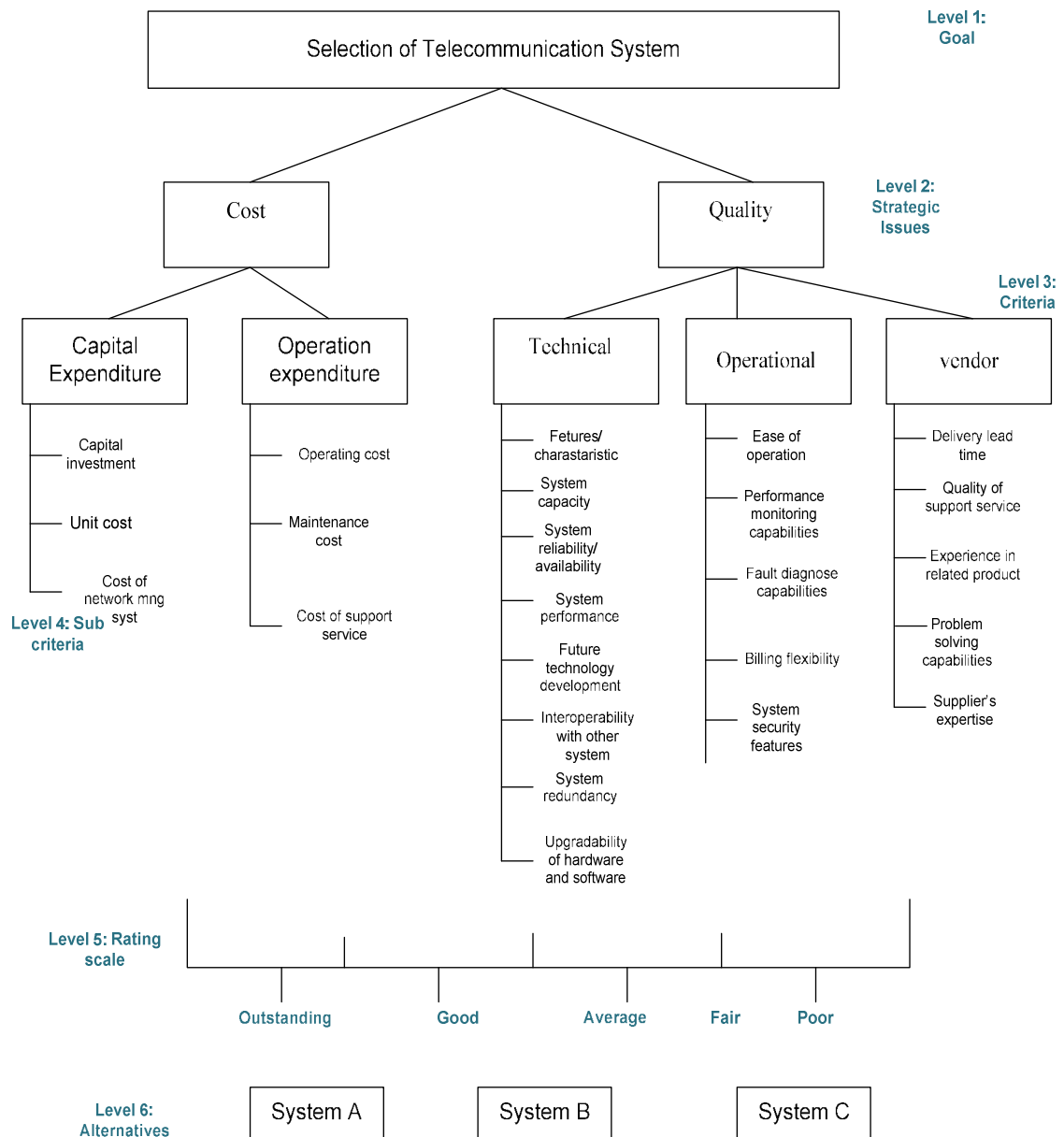
2. Measurement and data collection

The next phase, after building the AHP hierarchy, is the measurement and data collection, which entails forming a team of evaluators and assigning pair wise comparisons to the strategic factors, criteria and sub criteria used in the AHP hierarchy. The nine-point scale as suggested by Saaty is applied to assign pair wise comparisons of all

elements in each level of the hierarchy which will be translated into the corresponding pair wise comparison judgment matrices (PCJMs).

Table-7 shows the fundamental scale of absolute values for representing the strength of judgments.

Table (7): The fundamental Scale (Source: Saaty 2001)

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak	between Equal and Moderate
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	between moderate and strong
5	Strong importance	Experience and judgment strongly favour one activity over another
6	Strong plus	between strong and very strong
7	Very strong or Demonstrated importance	An activity is favoured very strongly over another, its dominance demonstrated in practice
8	Very, very strong	between Very strong and Extreme
9	Extreme importance	The evidence of favoring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity i has one of the above nonzero numbers assigned to it when compared to activity j, then j has the reciprocal value when compared with i	If x is 3 times y, i.e. $x = 3y$, then $y = x/3$ or $y = 1/3x$
Rationales	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

Using this approach, an assessment team comprised of senior engineers from the Engineering Department, Marketing Department and Operations Department who are often engaged in choosing telecommunications systems within the company is created. The insights expressed by them in their judgments are deemed to be representative of the company in assessing the telecommunications criteria and the selection requirements.

A questionnaire consisting of all strategic factors, criteria and sub criteria of the three levels of the AHP model is designed and is applied to gather the pair wise comparison judgments from all evaluation team members. The results gathered from the questionnaire are used to form the corresponding pair wise comparison judgment matrices (PCJMs) for determining the normalized weights.

3.   Determining normalized weights:

Using the geometric mean approach, the pair wise comparison judgment matrices obtained from evaluator team in the measurement and data collection phase are combined at each hierarchy level to obtain the corresponding consensus pair wise comparison judgment matrices. Each of these matrices is then translated into the corresponding largest eigenvalue problem and is solved to find the normalized and unique priority weights for each criterion. The software system called Expert Choice is used to

determine the normalized priority weights. The consistency ratio (CR) of each PCJM is also calculated.

4.   Synthesis finding solution to the problem:

The next phase is then to synthesize the solution for the problem. We combined the normalized local priority weights of strategic factors, criteria and subcriteria obtained from the third phase together with respect to all successive hierarchical levels to obtain the global composite priority weights of all sub criteria used in the fourth level of the AHP model. After calculating the global weights of each subcriterion of level 4, they are rearranged in descending order of priority.

The AHP model with all the strategic factors and the defining criteria and subcriteria, along with their global priority weights can be used in any selection problem.

Summary of Analytical Hierarchy Process:
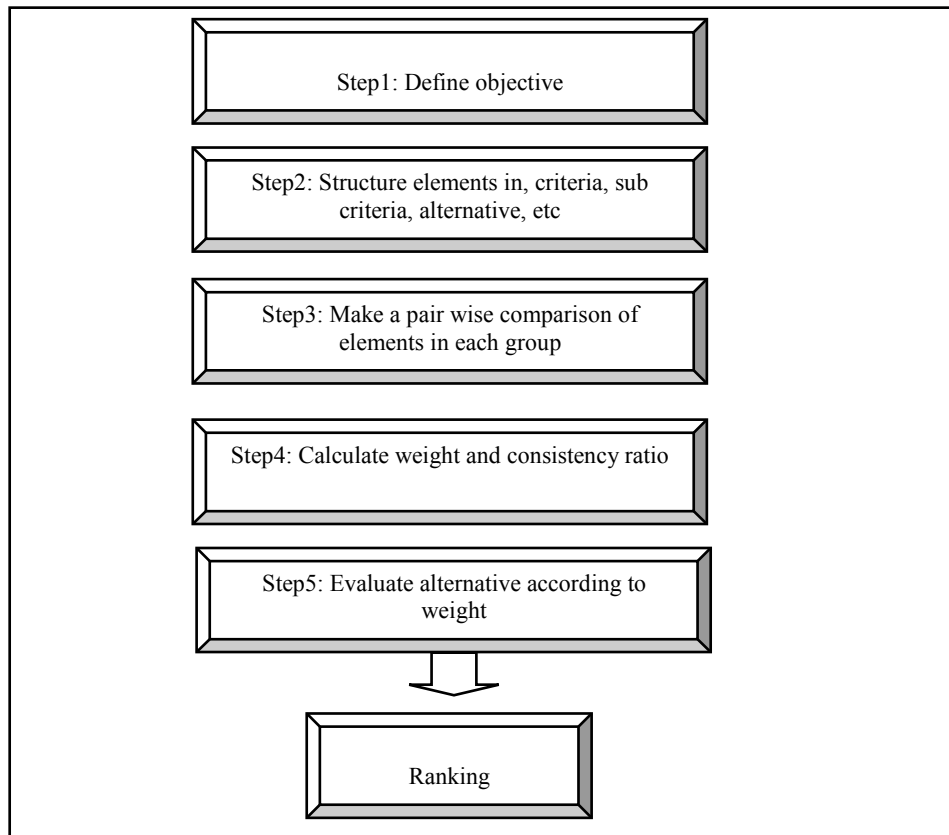
Advantages of the AHP Method:

Some benefits of AHP method provided the follow explanation.

i. The strong point of the AHP method lies in its capability to structure a complex, multi person, multi attribute, and multi period problem hierarchically (Saaty, 1980).

ii. Both tangibles and intangibles, qualitative and quantitative, individual values, and shared values can be included in the decision process.

iii. It necessitates the construction of a hierarchy of attributes, sub attributes, alternatives and so on, which facilitates communication of the problem and recommend solutions (Yusuff 2001).

iv. It does not need greatly intuition, experience, and theoretical knowledge of the domain expert as expert system (Yusuff 2001).

v. A significant benefit of AHP is its stability and flexibility in relation to changes within and additions to the hierarchy

vi. AHP method has the ability to position criteria according to its importance and needs which results in more accurate decisions in relation to the process of selection.

5.3 Validation Of Model:

As I mentioned earlier, a large number of models and theories have been developed to adopt a certain technology management framework.

It was obvious to notice that each firm has its own model of Technology Identification.

The Palestinian Telecommunication Company "PALTEL" is one of the largest service companies for whom I proposed, devised and developed the Technology Identification Model.

After I met with some of PALTEL's directors and managers, with whom I could review, discuss and amend the model, I found that they do

take care of some of the key components of the Technology Identification Model such as Market and Competitive Analysis. I found them very much interested with it. In fact I could get a high acceptance to this Model from them especially with what's called Technology road mapping which they considered as a useful technology planning tool in an increasingly competitive environment.

Regarding the selection model; PALTEL see AHP model as a good and practical methodology to conduct the process of picking and choosing the appropriate technology to the firm since it is a good way of combining quantitative and qualitative criteria to select between the various options available.

So, PALTEL has accepted the model and found that it was practical and valid for identifying and selecting technology to meet customer needs for Value Added Services.

Chapter Six

Conclusions and Recommendations

6.1 Conclusions and recommendations:

This chapter serves as a conclusion for this thesis, where main conclusions and recommendations are explained. In this research the technology management concept and its activities are explored and current practices at one of the large telecommunication firms were examined. A framework that suggests technology identification and selection processes was devised to enhance the current practices in the company. The research main conclusions can be summarized as follows:

1. PALTEL performs technology identification and selection in an ad-hoc manner.

2. The company does not pay importance to the issue of technological management.

3. PALTEL must adopt a more formal and structured approach to technology selection activity.

4. PALTEL performs scanning and monitoring for the emergence technology in an ad-hoc manner.

5.   Non-tracking of emerging technologies and technological advances increases companies' vulnerability to technology change.

6.   Quality improvement potential of new technology is considered the major qualitative gauge that influences the company's technology investment decision.

For PALTEL company to improve their technology management performance the following is devised:

1.   The concept of technology management should be given more attention by the company.

2.   PALTEL needs to lay more efforts in R&D to improve their technological competitiveness.

3.   PALTEL should have to devote and employs a dedicated team to work with technology management activities.

4.   The selected technology must serve up the competitive priorities of the firm.

5.   PALTEL should monitor technology emergence in systematic way in order to decrease their susceptibility to technological change.

6.   PALTEL must adopt a more formal and structured approach to technology selection activity

7.   PALTEL should select technologies that are aligned with their business and financial objectives.

8.   PALTEL needs a systematic process to make selection process.

6.2 Contribution to theory and practice:

This research makes several contributions to the case study. In summary, the principal contribution comes under two matters.

➢   The first is the contribution to theory; this contribution leads to the understanding of the technology management process and framework with highlight and focus on the topics of identification and selection (chapter 2). A comprehensive literature review has been carried out to understand technology management concepts and general strategic technology management issues and identification and selection processes were discussed to illustrate the relevance and contributions of each towards the improved TM methodology.

➢   The second is the contribution to practice; this involve developing a practical and helpful methodology that addresses the needs in the company. Using the empirical observations and meeting with relevant people involved in the process; a new framework has been developed to work out in order to enhance the methodology used in the company and improve its performance.

Appendix A

A list of questions that have been raised during the interview:

1. Does PALTEL currently   apply any certain approach in selection the new technology?

2. What are the criteria used in the process of technology selection? (How does PALTEL select technology for business benefit?)

3. How does PALTEL identify technology which will have a future impact on the business?

4. Does the technology used by the company meet the required purpose?

5. How does PALTEL keep up with technological development

6. If the company wants to adopt new technology, how does PALTEL make sure that the new technology is consistent with the company's policies and technological infrastructure?

7. Does PALTEL make scanning and monitoring for the modern technology?

8. How does PALTEL work with systematically monitoring and evaluating external technologies that have been identified as relevant to the company?

9. Who owns the responsibility for monitoring the development within one technology field?

10. How does PALTEL define the technology field that is going to be monitored?

11. What are the sources of the information that PALTEL usually use for monitoring technology developments?

12. How does PALTEL deals with disruptive technology?

13. Does PALTEL put a certain strategy in dealing with competitors?

14. What technology forecasting methods PALTEL most often use? Select all from the list that are relevant, or specify others if not on the list:

Delphi	Brainstorming	Market research	Scenario planning
Other:			

15. How many staff work on technology forecasting and, on average, for how long (e.g. percentage of their time or weeks per year)?

16. Does PALTEL regularly assess the state of the art of its key technologies

17. How does PALTEL assess the new technology?

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جامعة النجاح الوطنية

كلية الدراسات العليا

وضع منهجية لتحديد وتقييم واختيار التكنولوجيا المستخدمة في الشركات
الفلسطينية/ موضوع الدراسة شركة الاتصالات الفلسطينية بالتل

إعداد

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اشراف

د. حسام عرمان

قدمت هذه الأطروحة استكمالاً لمتطلبات درجة الماجستير في الإدارة الهندسية بكلية الدراسات
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الملخص

يعتبر قطاع الأتصالات أحد أهم القطاعات العالمية الأكثر تأثيرا وأهمية. فبالرغم من كونه ذا أهمية أساسية وجوهرية لصحة الأقتصاد الحديث الا أنه يمر بفترة من التغير غير المسبوق, مواجها مجموعة من التحديات الاستراتيجية من العولمة والتحالفات عبر الحدود، إلى التكنولوجيات المتغيرة ومتطلبات المستهلكين المتزايدة. فمع ظهور التكنولوجيا المتعددة وزيادة متطلبات الزبائن تواجه الشركات مجموعة واسعة من الفرص والتحديات من أجل الحفاظ على الميزة التنافسية. حيث يدرك مدراء الاتصالات مدى الأهمية الأستراتيجية للتكنولوجيا في تقديم قيمة وميزة تنافسية لشركاتهم والشبكات التي يعملون فيها.

تحديد التكنولوجيا الصحيحة والمناسبة والمستخدمة من قبل شركات الاتصالات واختيار المناسب والحديث منها أمر بالغ الأهمية، وينبغي أن يؤخذ بعين الاعتبار ويحظى بأولوية عالية. حيث أن هذه القضايا أصبحت أكثر أهمية بسبب إن التكلفة والتعقيد والتغير السريع في التكنولوجيا اصبح في ازدياد بالاضافة الى ان المنافسة ومصادر التكنولوجيا اصبحت على مستوى عالمي ، هذا وتتطلب أدارة التكنولوجيا من اجل الحصول على منافع وفوائد تجارية واضافة قيمة على المستوى التجاري الى وضع أنظمة وعمليات فعالة لضمان أن الموارد التكنولوجية القائمة والمحتملة داخل المؤسسة تتماشى مع احتياجاتها، الآن وفي المستقبل. بالإضافة إلى ذلك، فإن تأثير التغيرات في التكنولوجيا والأسواق تحتاج إلى تقييم، من حيث التهديدات والفرص المحتملة.

ج

تهدف هذه الدراسة وبشكل اساسي الى وضع إطار منهجي لتحديد واختيار التكنولوجيا المستخدمة في شركات الاتصالات والذي يستخدم لدعمها وتحقيق أهدافها من خلال نشاطات أدارة تكنولوجية متكاملة.